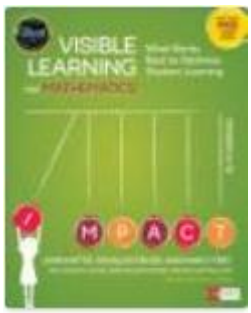
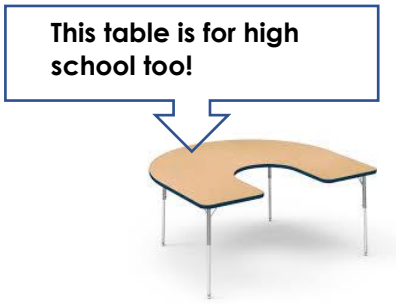
Differentiation in the High School Math Classroom

Secondary teachers may think that the buzz around pedagogy in math has little to do with their reality. While things certainly look different in a high school class, some things remain true, and other things have been overlooked. Secondary Mathematics has a focus on content, but our students really benefit from many of the practices that are a regular part of middle years classrooms. Hattie's work lists effect sizes of practices in math, and that research spans all grades including high school, so those practices are still powerful! Furthermore, our grades 10, 11, 12 curricula still involve all the mathematical processes, including allowing students opportunities to construct meaning, communicate, make connections, visualize, represent, and reason mathematically. In short, the things that we know are good for middle-years students are still good for high school students, yet become increasingly absent from their classroom reality.



1. **Guided Math** may look different at high school, but the general principal can still be applied. **Specific, timely, non-graded feedback** has a very high effect size (0.75). Having a small group of students gather at a "teacher table" provides an opportunity for the teacher to closely observe students working through procedures, and provide in-the-moment feedback. We sometimes call this "Math Workshops" or "Conference Table". Even if our students aren't working in small groups as routinely as middle years students, we can still arrange to have groups of students come work with us at a table. Often high school students have time to work at assignments independently, and we can call groups of students up to a conference table during that time.

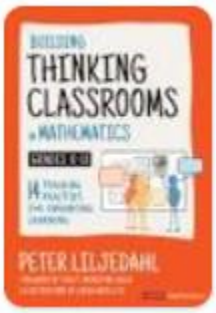


Some high school teachers do arrange small group work. Stations can include technology practice, doing an exploratory activity with graphing calculators or other technology; another station may involve doing a hands-on activity (exploration tasks, probability, timing objects and graphing rates, paper folding, measuring tasks such as angles, collecting data, determining and/or applying ratios, watching a video, creating a model, etc). Another group can be completing an assignment/written task, and of course a group with the teacher for more in-depth teaching and assessing, and feedback.

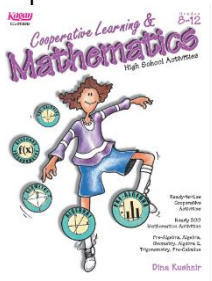
Many students are more comfortable engaging in mathematical dialog in small group rather than full-class discussion. This benefits First Nations learners and girls in mathematics. Teachers report improved

teacher-student relationships when they have opportunities to talk with students in small groups.

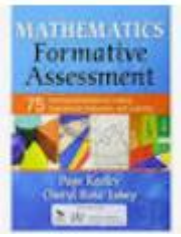
2. **White boards (Dry erase boards).** Of all the classroom tools we can give teachers, including computer programs, graphing calculators, tablets, chromebooks, etc, few things have as much impact as students having dry erase boards. Why?
    - They are part of the teacher conference table, as described in #1.
    - They boost engagement.
    - There is evidence that students take more risks when working with dry erase boards than in notebooks/paper-pencil.
    - A teacher gets an instant look at who understands and who doesn't, and can adjust instruction accordingly. Even used in whole-class, the teacher can ask questions and have students give short answers, work short problems, conjecture, select correct answers, show graphs, demonstrate strategies on white boards, and hold them up. By quickly glancing around, the teacher can determine students' level of understanding.
    - When students use white boards to answer questions ALL students are thinking and engaging in the learning. When answering orally, we call on one student to answer and sometimes that student is the only one that does the thinking.
3. **Vertical Surfaces**: use of dry erase boards is even further enhanced by using vertical surfaces. VNPS (Vertical non-permanent surfaces) have been shown to keep students thinking and on-task longer than paper/pencil or even individual dry erase boards. Standing to do mathematics has been found to stimulate better posture and mood which leads to more energy, and more perseverance at thinking tasks. Standing at dry erase boards is even better than flip chart paper, because students will take more risks when they can erase quickly, whereas flip chart work is large, public and permanent (Liljedahl, 2021).



Collaborative Learning and cooperative learning have high effect sizes (0.54, 0.59) and work well in high school classrooms. This may be as simple as students working through assignments together, or engaging in more complex collaborative tasks. Dina Kushnir's book Cooperative learning and Mathematics, Grades 8 – 12, has great ideas for cooperative tasks that are designed for high school content and can be adapted to fit many content areas. Learning collaboratively is culturally appropriate for First Nations learners.



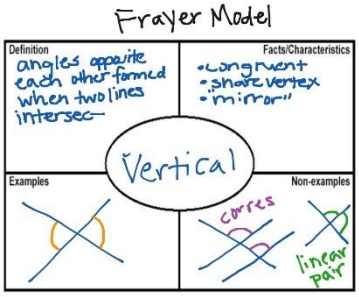
4. In secondary classrooms, **communication** is essential. Modeling think-alouds and having students practice them, using "elbow partners" or "think-pair-share", using class discussion, and providing opportunities for students to discuss and share strategies are effective classroom strategies.



5. **Formative assessments** (effect size 0.9) should be embedded frequently. Again, these can be fun activities that offer a break in the monotony of the lecture- practice-assess cycle that sometimes becomes are routine. They can be opportunities for students to reflect on their learning and provide teachers with feedback on what is working and what isn't. Using many sources of data collected over time improves the validity of our summative evaluation of students. Most importantly, research shows that formative assessment significantly improves learning.

   Students use formative feedback to judge their success in learning math. Research shows that few students make use of grades to gauge or adjust their learning, and while formative feedback is motivating, grades decrease student motivation (O'Connor, 2022).

6. **Concept Mapping** helps students consolidate learning, and has a high effect size (0.60) in mathematics. Frayer models are a great way to introduce or review concepts, and they tap into "similarities and differences", which has also been shown to improve learning in math.



Scaffolding. As math work becomes more complex in high school, scaffolding strategies may focus on mastering steps and procedures. **Interleaving worked examples** is a method of differentiating process and product for students. For struggling students, the teacher may provide examples of procedures as anchor charts or cards, or embed worked examples within the assignment for some students. Another method is to give the student an assignment with the first problem completed. The student analyzes and names the steps of the procedure. The second problem is nearly complete, and the student finishes it. The third example is partially worked, and the student completes it. The next example is only started and the student finishes it, and so on, until the student does the whole procedure independently.

Chunking across problems involves teaching students one step of a procedure at a time. They practice the first step across several problems, and then go on to the second step. They go back through the series of

problems that have the first step completed, and do the second step, and so on.

These two strategies are from Paul Riccomini's work in RTI in mathematics, helping students with cognitive overload (webinar).

7. **Parallel and open tasks** are ways of differentiating problems. Struggling students can be given tasks that are less complex or involve simpler computations, but are still in line with curricular outcomes. Open tasks have multiple entry points, and students of all abilities can experience success.
   https://makingsenseofmathematics.com/2019/10/02/differentiating-using-parallel-tasks-in-your-math-lesson/

   http://www.onetwoinfinity.ca/wp-content/uploads/2017/02/Parallel-tasks.pdf

   Robert Kaplinsky has a rich resource for creating open tasks
   https://robertkaplinsky.com/depth-of-knowledge-matrix-algebra-2/

8. Students in high school still need **movement** and hands on activities embedded within their class time, especially in our longer high school periods. Many formative assessment ideas or rich activities like those found in Kushnir's Cooperative learning in math can be adapted to any content, and provide chances for kids to move and change their focus. These opportunities to move enhance learning and recall and support our kinesthetic learners. Research shows that students remember more when more senses are activated during learning, and also that learning is socially constructed. There are many good resources for active activities at the high school level.

9. **Enrichment.** What do we do for our advanced learners?
   https://nrich.maths.org/secondary
   https://www.youcubed.org/tasks/
   https://mathforlove.com/lessons/rich-tasks/
   https://www.aboveandbeyondthecore.com/rich-math-tasks
   https://www.mathgiraffe.com/blog/structuring-guided-inquiry-in-secondary-math