Today, You Are the Math Coach!

Michelle Hilton, Shelley Strobel and Terry Freeman

The coach calls "Time!" A whistle blows. You are given a time out. This scenario is well known to many. But can a similar approach be used in math? The answer is a simple "Yes."

One of the big concerns today in education is engaging students in their learning. In addition to this focus on engagement, teachers are trying to provide timely formative assessment and make assessment *as* learning a priority. Four years ago, teachers in Medicine Hat School Division no 76 indicated a strong desire to explore cooperative learning to address this engagement of students. All teachers in the division were instructed in the Tribes Learning Process. The use of Tribes provides safety and community in a classroom; safety allows for students to be comfortable in working with others as well as sharing answers and learning together. This spurred the interest in additional learning strategies, which led to Kagan Cooperative Structures. Over half of the school division's teachers underwent training in this area immediately. From this learning, the middle school and high school math teachers underwent training designed for secondary math in which the focus was on cooperative structures that work best in the math classroom.

Cooperative learning is student-to-student interaction over subject matter as an integral part of the learning process.

What is cooperative learning? Spencer Kagan describes it as "student-to-student interaction over subject matter as an integral part of the learning process" (Kagan 2009). Cooperative learning is students doing the work and realizing that success comes from one another. Students have equal participation, participate frequently and are held accountable for their learning. Students cannot hide in this learning environment; they are required to participate. There are many reasons cooperative learning has been proven to work. It provides immediate and frequent feedback to students, it increases their on-task time and it provides frequent practice recalling and verbalizing math processes. In his online article, Kagan (2014) summarizes the work of State University of New York (SUNY). The chart below shows that the effect size of Kagan structures, in this case the Numbered Heads cooperative structure, is clearly positive.

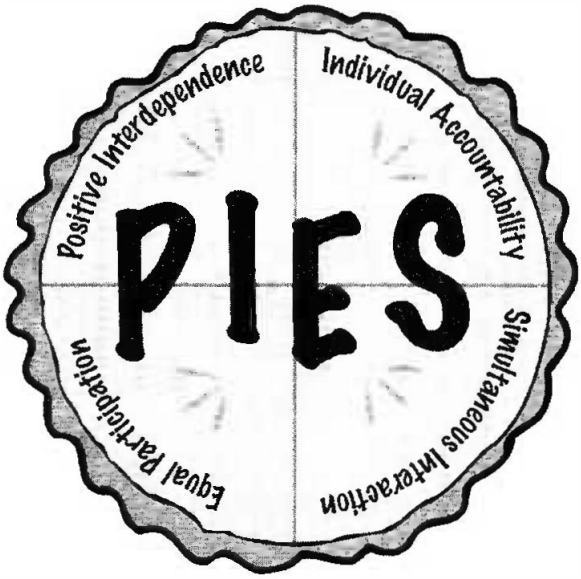
Kagan believes that when teachers consciously design learning situations with cooperation in mind, a wide range of positive outcomes is the result. That is the beauty of these cooperative structures. They have been carefully crafted, tried and applied. During teacher training, the structures are modelled and practised with real curricular content. Teachers are taught to view structures through the PIES filter (see figure at right). A structure can be called *cooperative* only if it meets these strict criteria.

What does this look like in the classroom? Michelle Hilton, a middle school math and science teacher with Medicine Hat School Division no 76

Effect of Kagan Structures on Achievement

Study	Effect Size	Percentile Gain
1 Numbered Heads vs Whole Class Question & Answer[16]	95	33.0
2 Numbered Heads + vs Whole Class Question & Answer[17]	98	33.5
3 Numbered Heads vs Whole Class Question & Answer[18]	78	28.2
4 Numbered Heads + vs Whole Class Question & Answer[19]	96	33.2
5 Response Cards vs Whole Class Question & Answer[20]	90	31.5
6 Numbered Heads vs Whole Class Question & Answer[21]	95	33.0
7 Numbered Heads vs Whole Class Question & Answer[22]	89	31.2
Average	.92	31.9

Kagan 2014



since 2004, and Shelley Strobel, a senior high math teacher with Medicine Hat School Division no 76 since 1994, reflected on their experiences in the classroom using cooperative learning structures and pursued additional training. Out of their Kagan training they petitioned Medicine Hat School Division no.76 to have Kagan Secondary Math brought to Medicine Hat for the teachers to have the same training they experienced. They both describe cooperative structures as the game changer in their classrooms. Student engagement and assessment results have improved after the use of these cooperative structures in their classrooms.

They summarize a few of these cooperative structures that have been successful in their math classrooms below:

An excellent and easy Kagan structure is called Mix-Pair-Share. This structure promotes movement, which is good for the brain. Social interaction occurs because students are required to pair up with a new partner for each question. Class building is happening because students are out of their desks interacting with other students. This structure easily meets the criteria for PIES in the cooperative learning situation. In Mix-Pair-Share, students mix around the classroom until the teacher calls to pair up. Students pair up with the person closest to them (students who haven't found a partner raise their hands to find each other). The teacher asks a question and gives students time to think. Students then share their answer to the question with their partner using the Kagan structure called Timed Pair Share (students are given a specified time to respond to the question and switch when time is up) or they use the Kagan structure RallyRobin (students take turns responding to the question), depending on whether you want students to have equal sharing time. This structure can be used for class building or content.

The math classroom of the past would ask students to practise concepts by tackling textbook questions individually and reviewing them the next day before a worksheet was assigned for individual completion. This method has the teacher running ragged around the class, attempting to coach students that were having difficulty and monitoring students' behaviour. If students are engaged and taught how to be coaches themselves, the achievement gap will be lessened over time. A cooperative math classroom shifts the responsibility of learning away from the teacher and onto the students. Learning shifts from being a spectator sport to one where students are consistently active participants. In a traditional class the teacher asks a question and calls on one student for the answer, effectively having possibly only one student actively on task at that moment. In a cooperative class the teacher would ask a question, provide think time and then have the students share with their shoulder or elbow partner. Now 50 to 100 per cent of the class has had the opportunity to share ideas.

A cooperative lesson may follow this pattern: teacher-directed notes with examples, but after each example a structure could be inserted for students to practise the newly taught concept. For example, after teaching a lesson on the sine law the teacher could use the Kagan structure RallyCoach to give students an opportunity to verbalize the steps of solving a triangle using the sine law.

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- RallyCoach has students working with their shoulder partners. Person A is given a question to solve by talking out the process while Person B watches and listens, checks and coaches if necessary. For the second question the pairs switch roles. The key to making a difference in math learning is this verbalized piece. "Verbalization increases internalization" (Jeff Dane, Kagan instructor).

Preparatory work for the Kagan structure called Showdown.

- RallyCoach can also be used for completing the assigned practice questions. Students work in pairs, coaching each other along the way to mastering the math concept being taught. The setup consists of the teacher creating a two-column worksheet, with questions on each side that require a similar process to solve. The worksheet is folded in half so only one column can be seen at a time. The coach will hold the pencil and the other partner will be required to verbally explain the process that he or she thinks would be best to solve the question at hand. It is important that the student explain the steps to the coach step by step. If the coach agrees with the process he or she will pass the pencil over so that the partner can write the answer down. If the coach does not agree, he or she will give the partner tips and coach the partner to the right process. Once both agree that the question is completed correctly, the coach gives the partner a specific praise. Then the paper is flipped over and roles are switched. Not only is content being mastered in an engaging, meaningful way, but students are also practising social skills that they will take with them outside of the school walls.

Engagement recognizes the need for students to be participants in their learning.

- The structure Pairs Check is similar to RallyCoach but adds another level of accountability. In pairs, students take turns solving problems as described above. After two problems, students check their answers and celebrate with another pair. This pattern continues until the worksheet is complete.

Engagement recognizes the need for students to be participants in their learning. Cooperative structures provide the vehicle to increase student engagement. Another excellent Kagan structure that focuses on verbalizing the steps and can be used daily is Sage-n-Scribe.

- After a concept with examples has been taught, the class is given two "Your Turn" questions. Student A would be the sage first and have to explain how to solve the problem. Student B, the scribe, would record the sage's work only if he or she agrees with what is being said. This gives student B the opportunity to coach if student A misses a step; it also gives student B a chance to ask questions about the process. For the second "Your Turn" question, students switch roles. A couple of things are happening here. By talking it out or having to coach, students retain more of what they learned than if they used a traditional method of trying the example on one's own. As well, the engagement is well approaching 100 per cent in the classroom. This frees up the teacher to help specific individuals or partner groups in the classroom.

Another example of using Kagan cooperative structures in the senior high math class is the day before a unit exam. A structure like Quiz-n-Show works well.

- For Quiz-n-Show, students are each given their own whiteboard, pen and eraser. The teacher presents a problem on the board and allows think time, and students solve the problem individually. Think time is about three to five seconds. This is crucial—it levels the playing field because it makes students pause before rushing to answer the question. It allows the slower processor to have thinking time. When teacher calls "Show," students show their answer to their shoulder or face partners (as directed by the teacher) and the teacher writes the answer on the board. Students at this point are praising each other for a job well done or are coaching and redoing the question.

There are more than 200 Kagan cooperative structures to explore and use in classrooms to increase the engagement of your students in learning content areas. Other well-used structures are Quiz, Quiz, Trade; Single RoundTable; and Jigsaw (expert groups). Engaging students goes far beyond what we used to

Time on task is significantly increased.

call "group work" and pulls them into active reinforcement of content through these cooperative activities. Time on task is significantly increased.

For these two math teachers, there was a choice. Do they remain the "stand and deliver" teacher with some students engaged and the goal just to finish the sheet or textbook page? Or do they want the kind of classroom where all students are consistently engaged and accountable to each other? Cooperative learning structures make formative assessment more relevant and assessment *as* learning a priority.

References

Kagan, S. 2014. "Effect Size Reveals the Impact of Kagan Structures and Cooperative Learning." *Kagan Online Magazine* Winter.

Kagan, S, and M Kagan. 2009. *Kagan Cooperative Learning*. San Clemente, Calif: Kagan.

Additional Resources

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