Unsolved K-12, November 15-17, 2013

Prior to the conference, there had not been a robust discussion among mathematicians and educators about using unsolved problems in the K-12 classroom.

History & Bio:

Starting in 2005, I introduced the 1937 Collatz Conjecture to grade 4 students in Calgary. The enthusiasm for the problem was tangible. At the end of each class I invariably lied to the students about there being a $1,000,000 reward for a solution. I heard back from parents and siblings, so this act of deceit helped the problem spread outside the classroom.

In 2007 I started using the Ringel, Kotzig & Rosa's Graceful Tree Conjecture (1967) in grade 3, and Issai Schur's Sum Free Partitions (1916) in grade 2. A tentative list of 13 unsolved problems was bounced off Jim Carlson of the Clay Mathematics Institute and when MathPickle was opened in 2010 a YouTube video of these unsolved problems was prepared. Over 60,000 people have watched this video in the last half year: http://youtu.be/JPhqhZvXlhQ

Despite the interest, it was unsure how best to move forward. One issue with the initial set of problems was that it was driven too much by me. It would be better if a group of mathematicians and educators would come together and find consensus about the selection of the 13 unsolved problems. Hence it was decided to propose Unsolved K-12.

James Tanton was the obvious choice of a co-organizer. He had been a strong supporter from the start, has largely the same vision of mathematics education, and complements me by being most at home in high school (I'm most at home in elementary and middle school.) James Tanton is also excellent from the podium and empathetic to the the needs of a diverse audience. This ended up to be a huge asset in the conference. He is also well connected in the United States so more than half of the mathematicians who attended came through his connections.

At the conference:

Only a fraction of unsolved problems are suitable for the school classroom, however there still are a huge number to choose from. We began by discussing the criteria that we should adopt when selecting the unsolved problems:

•The problem is curricular. For example, Goldbach's Conjecture (all even prime numbers more than two are the sum of two prime numbers) seems good for grade six students learning about prime and composite numbers, but it emphasizes addition too much for the grade six curriculum – hence Goldbach's Conjecture was not be selected.

•The problem is fun for the students. For example, the Gauss Lattice Point Problem (how many lattice points fit in a circle was curricular based for high school students working with conic sections, but failed to inspire many students. The same problem worked better in grade three where the curriculum connection is area measurement.)

•The problem does not confuse students. For example, exploring Multiplicative Persistence is curricular based and fun for grade 4 students learning multiplication, but a few students subsequently became confused about normal multiplication rules – hence Multiplicative Persistence was not selected.

•The problem is easy & cheap to implement by the teacher. For example, dice are common manipulatives in elementary schools, hence the use of dice should be both easy & cheap.

•The thirteen problems are as varied as possible.

The conference sought not only to select the unsolved problems, but also to start the process of working them up into classroom-friendly lessons that can be a practical guide to students.

The selection at the conference was as follows, but there is still active debate on some of these choices:

K. Optimal Neural Network - ImageNet Annual Competition, 2013
1. Cookie Monster Problem - Vanderlind, Guy, Larson, 2002
2. Sum-Free Partitions - Issai Schur, 1916
3. The game Aggression - Eric Solomon, 1973
4. Collatz Conjecture - Collatz, 1937
5. Fold it flat (an unsolved problem from Origami) - Thomas Hull, 1994
6. Heilbronn Triangle Problem - Heilbronn, c. 1950
7. Erdős-Straus Conjecture - Paul Erdős & Ernst Straus, 1948
8. Prime Number Catacombs - William Paulsen, 2000
9. Tiling Rectangles with Squares of Different Sizes - Stuart Anderson, 2013
10. Imbedded Square - Otto Toeplitz, 1911
11. Non-transitive dice - Brian Conrey et al, 2013
12. Undecided

The primary output from the conference is a video of the selected and discarded problems:
http://www.youtube.com/watch?v=wV5-wMGRM3g&feature=share&list=PLSrbLTVLJpchKVD0uUOEa2S-eSK9a3Kxp