Caribou Math Contests:

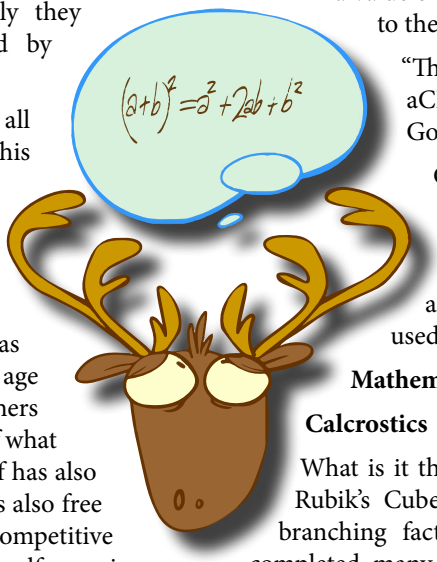
Not just a contest but a way of learning and enjoying math

Last issue we discussed how math can be made fun in order to make it a more enjoyable subject for students. Recent news reports found that many teachers struggle with just trying to get through the lesson plans, and often make any enjoyment of the subject take a backseat.

Thomas Wolf of Brock University thinks that learning and using math does not need to be dry, and to prove this he has developed Caribou Math Contests. Dr. Wolf has divided these contests into six separate events spread across a school year, into five different grade categories. So, for each online contest event there is one for grades 3-4, 5-6, 7-8, 9-10, and 11-12.

"What is special with Caribou Contests is that they are held online which allows us to post all results and statistics on the evening of the contest day. The contests feature interactive questions as well as multiple choice questions, and finally they require minimal effort to be administered by schools," says Wolf.

The web portal for the contest also showcases all previous contests as online practice tests. This allows anyone to attempt them and then see which rank they would have obtained in the real contest. They are also used as a teaching tool within the class room together with video solutions. In order to ensure that all students have access to these contests, Wolf has maintained that all contests for the youngest age group are to remain free of charge, while the others are yearlong ones that only charge about half of what other similar contests do for a single use. Wolf has also made sure that the first contest of every year is also free of charge. Part of the fun, and even in a non-competitive way, is testing out some of these questions yourself, even in the younger age groups.



"We have a relatively wide spectrum of easy and hard questions. All students can be successful in some questions and for even the best students some problems are really challenging," he says.

The variations in difficulty serve a number of purposes within the test questions. The first is to make sure that all ranges of ability and instruction can answer a good portion of the questions.

"Most questions can be done in a few seconds if one has a good idea so the better part of the 60 minutes are available for the few harder questions," Wolf explains.

"Also, for having a ranking distinguishing between 3000 participants, one needs more than a few hard questions. But more importantly, what we want to achieve is to introduce many students to the excitement and fun of thinking about mathematical problems. The most time our participants think about mathematical problems is not the time during the contest but the time spent on our practise tests and video solutions before and after the contest as one can see from our online statistics of over 400,000 practice tests taken since 2009."

The actual learning of how to solve questions is supported by a Caribou Contest YouTube channel. In the clips a volunteer student (Oliver Wolf) explains some of the complicated and fun math behind some of the math questions. Part of the interesting thing to watch is that it has been the same volunteer since the channel start in September 2011. With three years under his belt, you can see him grow from an elementary student into a high schooler, with many interesting haircuts along the way.

The contests are not only innovative in the openness in which they are administered, but in some of the technology and puzzles that were developed specifically for them. One of the puzzles that Wolf has developed he calls a "calcrostic problem".

These puzzles are similar to a Sudoku or magic square puzzle where a value entered into a "box" must interact in specific way to the surrounding values.

"The name is derived from CALculational aCROSTIC problem, - it's a word not known to Google before," explains Wolf with a bit of pride.

Caribou boasts a number of math based games that can be accessed at any time, and have been over two-million times since 2011. These classic games are used to boost the confidence and analytical thinking skills, and they are also used as interactive questions in contests.

Mathematical Developments

Calcrostics

What is it that makes some puzzles addictive, like Sudoku, Rubik's Cube or cross word puzzles? They have a high branching factor of possible steps for solution but when completed many rewards follow: In Sudoku each found digit satisfies three requirements (the row, the column and block), when Rubik's Cube is completed the player is rewarded 6 times when looking at all uni-colour sides. In crossword puzzles a letter typically completes two words. Puzzles, like:

EDKH	÷	KF	=	AA
-		+		+
EDB	x	J	=	EHCG
=		=		=
EEJD	-	DK	=	EEAE

where each letter stands for a digit give 6 rewards, 3 horizontal and 3 vertical correct computations.

In an attempt to improve such puzzles Wolf created similar ones which give even more reward when being solved with two more diagonal conditions, like:

AB	+	AB	=	BC
-	x	-	÷	+
DE	x	E	=	FE
=	=	=	=	=
C	x	DC	=	DBB

Furthermore it was possible to create a scheme which allows to create instantly infinitely many such puzzles.

Since January 2010 their web page has a daily new calcrostic problem and the solution of previous day's problem. Also the North East Asian Mathematics Competition held March 2015 in Nanjing, Jiangsu, China, with participating high school students from nine Asian countries had, as part of their event, one contest that exclusively featured calcrostic problems from Caribou.

Correlation of Solutions

Caribou wants the contests to be fair and therefore are interested in unlikely correlations between answers of different students at one school. A first version of their correlation test was based on the assumption that all questions are equally hard and all wrong options are equally often selected. A newer version takes into consideration how often each question was solved correctly and how often each of the wrong options was chosen, both depending on the strength of the students. This generalization is possible due to the large number of participants in each contest.

Arbitrary Size Sudoku

The Caribou interactive games, like Mastermind, Sudoku and Nim are freely available online for practise. Most have an unlimited number of initial positions to play against. The usual 3x3 Sudoku giving a (3x3)x(3x3) square can already be challenging. What Wolf developed is a method to generate a large class of arbitrary size Sudoku. The generation of arbitrarily large and difficult Sudoku is possible in a time only growing linearly with the area of the puzzle. What does take longer is to generate Sudoku that are minimal in the sense that taking away any initial number would give up the property of a unique solution.

Colouring Maps

A game to colour maps with a minimal number of colours is already available online by a different publisher. But that game has a fixed number of initial maps to colour. The Caribou floodfill program is able to generate an arbitrary number of initial maps with different connectivity properties and arbitrary size giving a rich source to study solution strategies.

Presented with "Caribou Cups" - top student in each grade
Back Row: Ian Kennedy & Cory McLean
Front Row: Dillon McLean Gr. 4, Isaac Puar Gr. 5, Reese Tam Gr. 3
Collingwood School . West Vancouver, BC

Coming Soon

New interactive questions to be available in the coming school year include interactive geometry constructions, map colouring, the Hackenbush game, Tangram and the Sokoban game.

All contest information, and how to participate, is available on the Caribou home page cariboutests.com.

Caribou Contests is grateful to the Fields Institute for the support received over the previous years.

Thomas Wolf has provided the fun but difficult puzzle below, the solution will be available next issue!

abe	$-$	j	$+$	$-hcbhgb$	$-$	hf	$+$	hb	$-$	hb	$-$	$-hchbef$
$-$	$-$	$+$	$-$	$+$	$+$	$+$	$\times$	$+$	$-$	$\times$	$-$	$-$
j	$-$	j	$+$	hf	$-$	hj	$-$	b	$+$	hi	$-$	hb
$-$	$+$	$-$	$-$	$+$	$+$	$+$	$-$	$+$	$+$	$+$	$+$	$+$
$hcbhge$	$-$	j	$\times$	i	$-$	d	$+$	$-ia$	$-$	$hcbfde$	$+$	e
$-$	$+$	$+$	$-$	$-$	$+$	$-$	$+$	$-$	$+$	$-$	$-$	$-$
$-he$	$-$	$-cja$	$-$	c	$+$	c	$+$	f	$-$	$-hchgjc$	$-$	$hcbfge$
$-$	$-$	$-$	$+$	$-$	$+$	$+$	$-$	$+$	$-$	$-$	$-$	$+$
dbd	$+$	$-becidh$	$+$	$-cga$	$-$	hah	$+$	bid	$-$	bfh	$-$	$-becihb$
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