

# Math Circle @ Racquet Up Detroit

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Racquet Up Detroit (RU, <http://racquetup.org/>) is a 501(c)3 after school program, serving Detroit Public School students (grades 5-12) in Northwest Detroit.

- The program offers the game of squash, academic enrichment support, community service, and mentoring.
- Almost 100 students. ~60% female, ~40% male overall.
- ~96% of the students are African-American.

# Math Circle @ Racquet Up Detroit

## Quick Facts

- Started in Summer 2017, funded by Tensor-SUMMA.
- 13 Math Circles so far, organized by LTU faculty and students.
- RU students mostly attend math circles on a voluntary basis.
- The student numbers at each session ranged from 31 to a low of 5.
- Mainly 7th and 8th graders, some 6th graders; a few high schoolers.
- Meetings are split into 2 or 3 sessions, as students spend half time at squash and half at academics.



# Math Circle @ Racquet Up Detroit

## Objective

We aimed to offer RU students who would not get opportunities for math enrichment the chance to discover the joy of problem-solving and the beauty of math in an environment where they would be supported by the group, group leaders, parents and teachers.



# Some of the topics covered

- 3-D Sierpinski tetrahedron (fractals)
- The Penny Game (winning strategies)
- String art valentine cards (construct curves using tangent lines)
- Snowboard and figure skating rotations (degrees and radians)
- Code breaking and code making
- Spaghetti and marshmallow bridges (stability)

# Lessons Learned

## 1. “Hook” the students with effective “baits”.


- attracting flyers

YOU'RE INVITED ...

**PI DAY @ RU**


**MATH CIRCLE**

WEDNESDAY, MARCH 14 (3.14)



Fun stuff with Pi  
Then get to eat pie

Pi and the Olympics:  
halfpipe snowboard



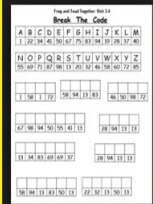

Racquet Up Detroit

**Cryptography Math Circle**

Wed., April 25, 2018

Break the code!

Make the code!



Racquet Up Detroit


**Build a Bridge**

**Math Circle**

Wed., May 23, 2018

What makes a stable structure?

Build with spaghetti and marshmallows!




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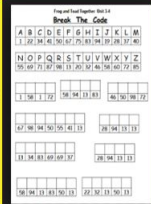

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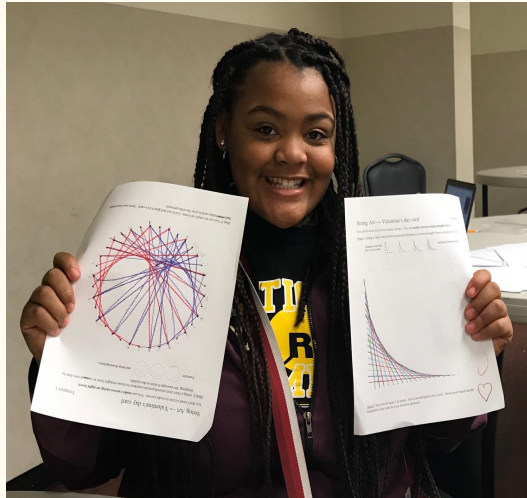
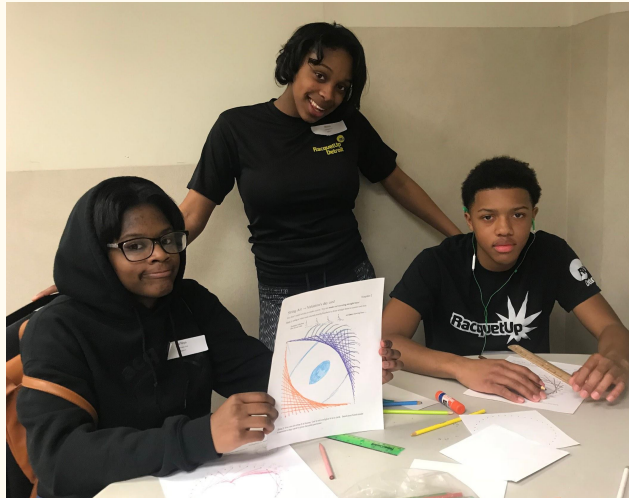
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# Lessons Learned

## 1. “Hook” the students with effective “baits”.

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- refreshments (pies, cookies, candies, marshmallows...)
- something they can keep (Valentine cards, Spaghetti bridges...)





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# Lessons Learned

## 2. Students like hands-on projects.

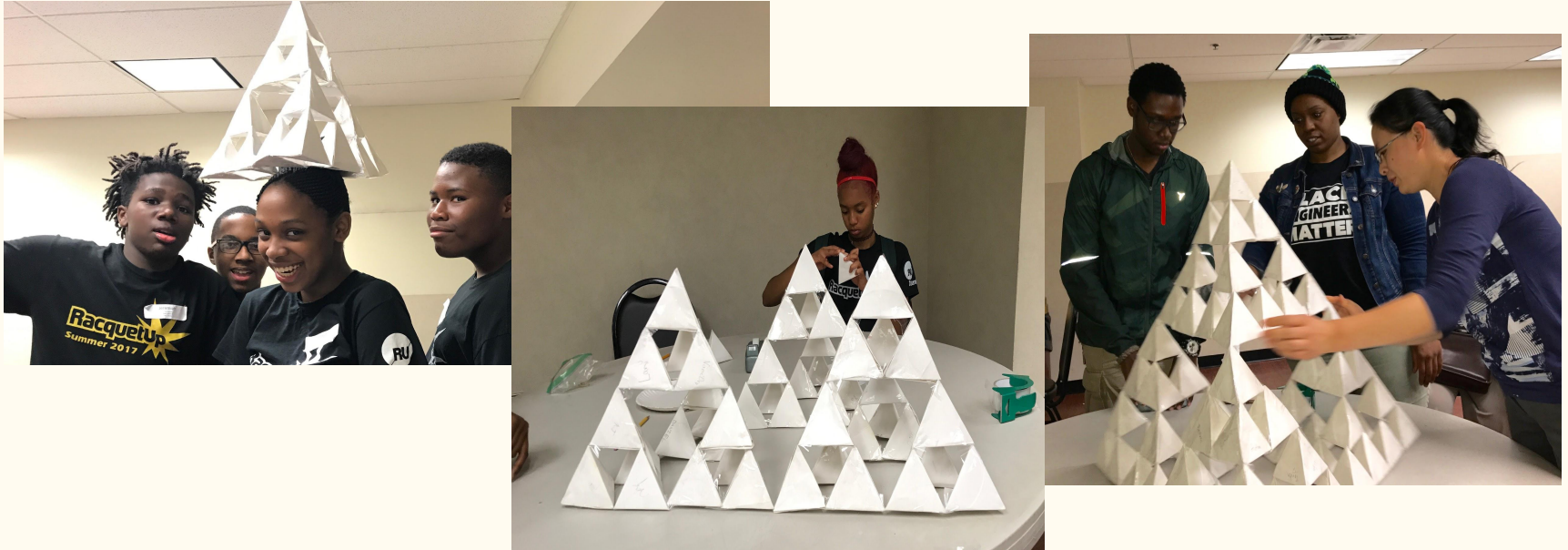
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# Lessons Learned

## 3. Short sessions (some 30 minutes)

Session times dictated by RU schedule, leaving time for homework.

- suitable with the attention span of middle-school students
- need focused planning (time arrangement, worksheets and etc.)

# Sample student worksheet at Pi-Day Math Circle

Racquet Up Math Circle

Pi Day, 3.14 (2018)

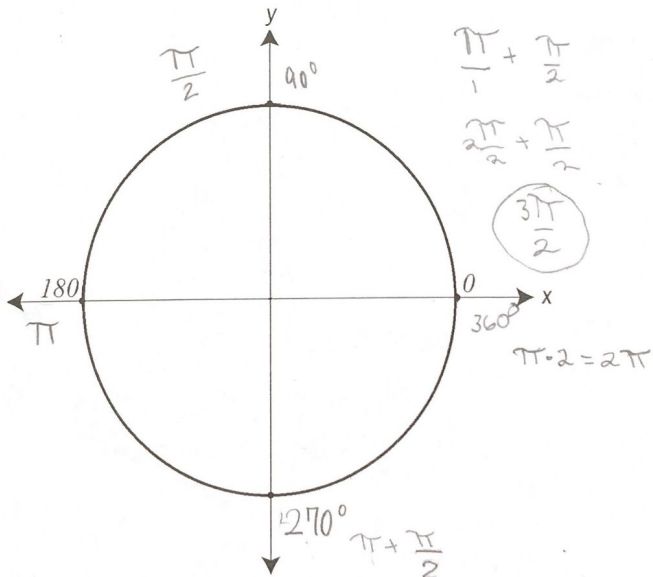
Name: Lawrence Johnson  
Eddie

How do the snowboarders and slopestyle skiers do those multiple turns?

How many turns in the air can they do? How do these rotations relate to Pi?

First, **degrees** (due to the ancient Babylonians)

Next, **radians** (due to the ancient Greeks)



(1) If one measure of an angle is given, can you find the other measure for it?

Degrees	Rotations	Radians
180	$\frac{1}{2}$ or 0.5	$\pi$
360	1	$2\pi$
540	$1\frac{1}{2}$	$3\pi$
720	2	$4\pi$
900	$2\frac{1}{2}$	$5\pi$
1080	3	$6\pi$
1260	$3\frac{1}{2}$	$7\pi$

$$\begin{array}{r} 360 \\ \times 2 \\ \hline 720 \end{array}$$

$$\begin{array}{r} 360 \\ + 180 \\ \hline 540 \end{array}$$

$$\begin{array}{r} 720 \\ + 180 \\ \hline 900 \end{array}$$

(2) The announcer says excitedly "Shaun White just did a 1440!"

How many turns in the air did he do? 4

What is the radian measure of the rotation?  $8\pi$

(3) Challenge problem!

Degrees	Rotations	Radians
90	$\frac{1}{4}$ or 0.25	$\frac{\pi}{2}$
180	$\frac{2}{4}$ or 0.5	$\pi$ or $0.5\pi$
270	$\frac{3}{4}$ or 0.75	
360	$\frac{4}{4}$	$2\pi$ or $2.5\pi$
540	3.25	

$$\begin{array}{r} 1260 \\ + 180 \\ \hline 1440 \end{array}$$

$$\begin{array}{r} 180 \\ + 90 \\ \hline 270 \end{array}$$

# Sample student worksheet at Cryptography Math Circle

Decode -- Encode  
Decipher -- Encipher

RU Math Circle 4/25/18

Name Gamygn

f. The square below is called the "Polybius Square". It was described by the ancient Greek Polybius in about 150 BC in his book "Histories".

We will encode and decode messages, and find out some of the history of this cipher.

	1	2	3	4	5
1	(A)	B	C	D	E
2	F	G	H	I/J	K
3	L	(M)	N	(O)	P
4	Q	R	S	(T)	U
5	V	W	X	Y	Z

Using the grid, can you encipher the message: "We escape tonight"  
Explain to the group how you did it.

52, 15, 15, 43, 13, 11, 35, 35, 15, 44, 34, 33, 24,  
22, 23, 44

Decipher the message: 32 15 44 23 34 14 24 33 44 23 15 32 11 14 33 15 43 43

Method in the address  
Method in the address

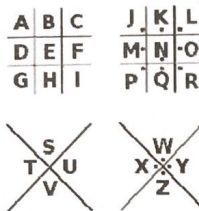
Why do you think "I" and "J" are in the same square?

because there is not enough boxes

## Cryptography Worksheet — The Pigpen Cipher

⋈ 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

The Pigpen Cipher is a **Substitution Cipher** that was used by the Freemasons in the 18th Century. They substituted each letter of the alphabet with a picture.



Using the diagram on the left, can you decipher the two mathematical words below?

⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈  
PARALLELLOGRAM  
⋈ < ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈  
QUADRILATERAL

trapezoid  
king

Discuss in pairs how the cipher works.

Write a short message of your own using the Pigpen Cipher, and ask the person sitting next to you to decode it.

How easy is it to work out what someone has written using this cipher? Can you think of any ways to make it harder?

Make your own "key" (a set of grids like that above) and encode a short message using your own cipher.

# Lessons Learned

## **3. Short sessions (some 30 minutes)**

Session times dictated by RU schedule, leaving time for homework.

- suitable with the attention span of middle-school students
- need focused planning

## **4. Student-Facilitator ratio.**

Having enough facilitators for one-on-one help was good.

# Assessments

**Original aim was to offer both high school and middle school circles.**  
We will work with RU staff to schedule high school sessions in addition to middle school.

Student surveys from fall and spring show that students got the math behind the projects, thought them challenging and fun, and thought the time was adequate. (One student wanted to do it every week.)



# Acknowledgement

- Tensor-SUMMA grants (Strengthening underrepresented Minority Mathematics Achievement)
- Faculty and student facilitators from Lawrence Technological University
- Staff members and volunteers from Racquet Up Detroit
- Thank you, too!