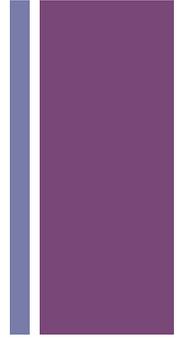


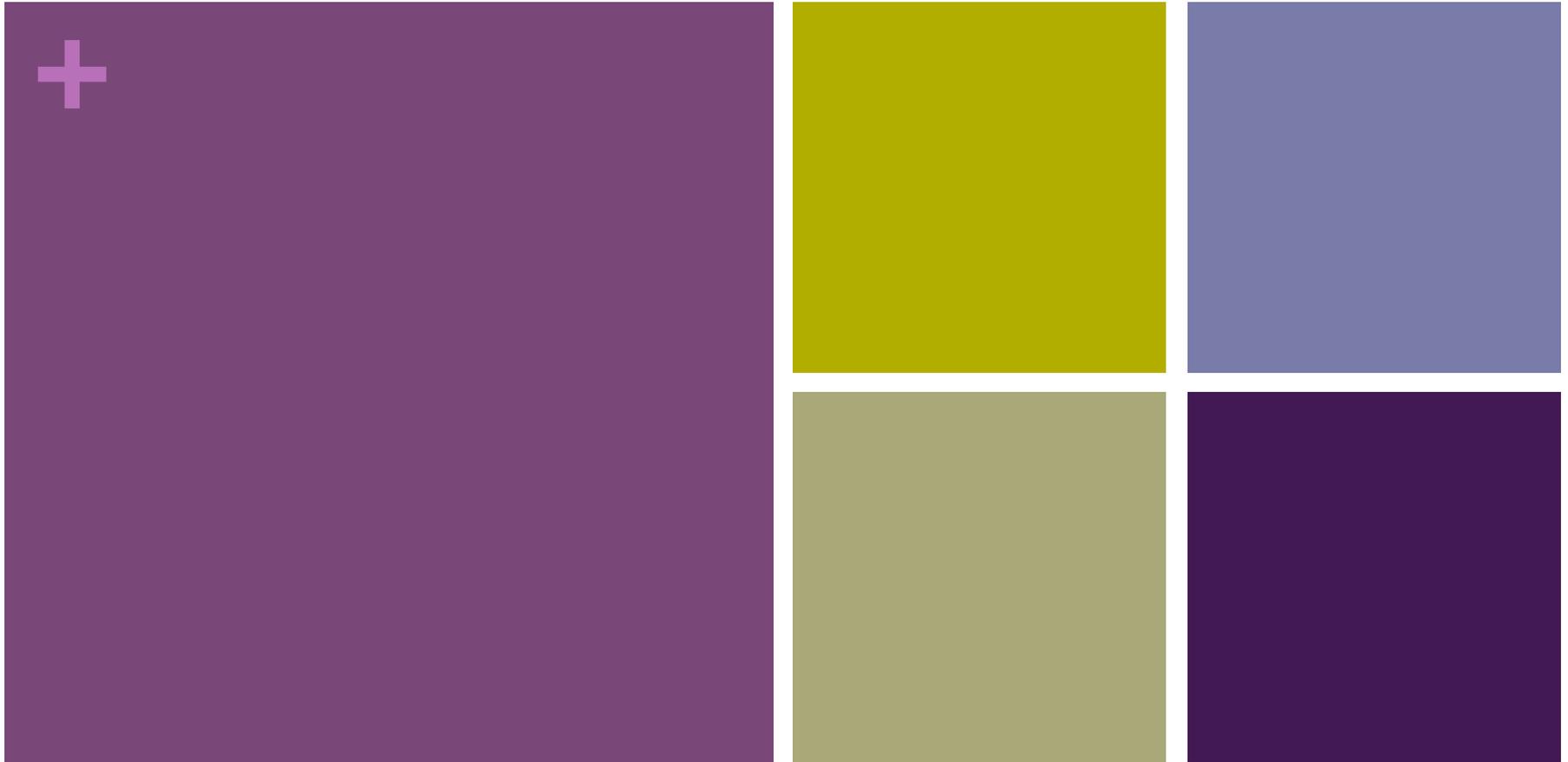
+ Icebreaker



What does equitable math teaching mean to you?

Individually and as a group, write your ideas on the poster.

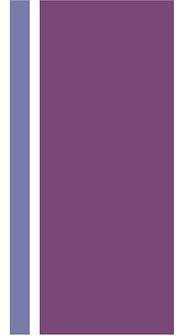
Throughout the session, add any new ideas or insights.



**Classroom experiments:
Action research towards teaching math for
social justice**

Toronto Radical Math Study Group
CBUW 2012

+ Presenters



Teachers:

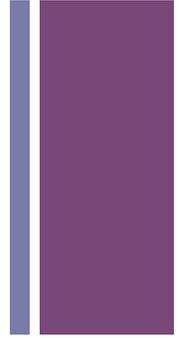
- Beth Alexander, The Linden School
- Krissy Budny, Richview CI
- Lisa Cantor, Toronto Montessori Schools
- Emily Clair, Sir Wilfrid Laurier CI
- Matt DeClerico, Jarvis CI

- Michelle Munk, The Linden School
- Kaya Taché-Green, Central Technical School

Researcher/facilitator:

- Indigo Esmonde

+ Organization of the Session

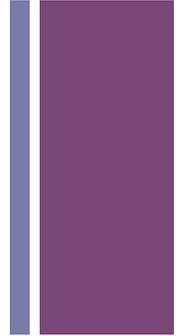


- Introduction – Action Research and Equity
- Action Research Projects
 - Lisa
 - Beth
 - Kaya and Michelle
 - Matt
 - Krissy
- Reflections on Action Research
- Q&A



+ Introduction to the Radical
Math Study Group activities

+ The Project



■ Radical Math Study Group

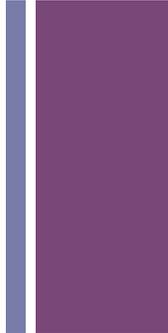
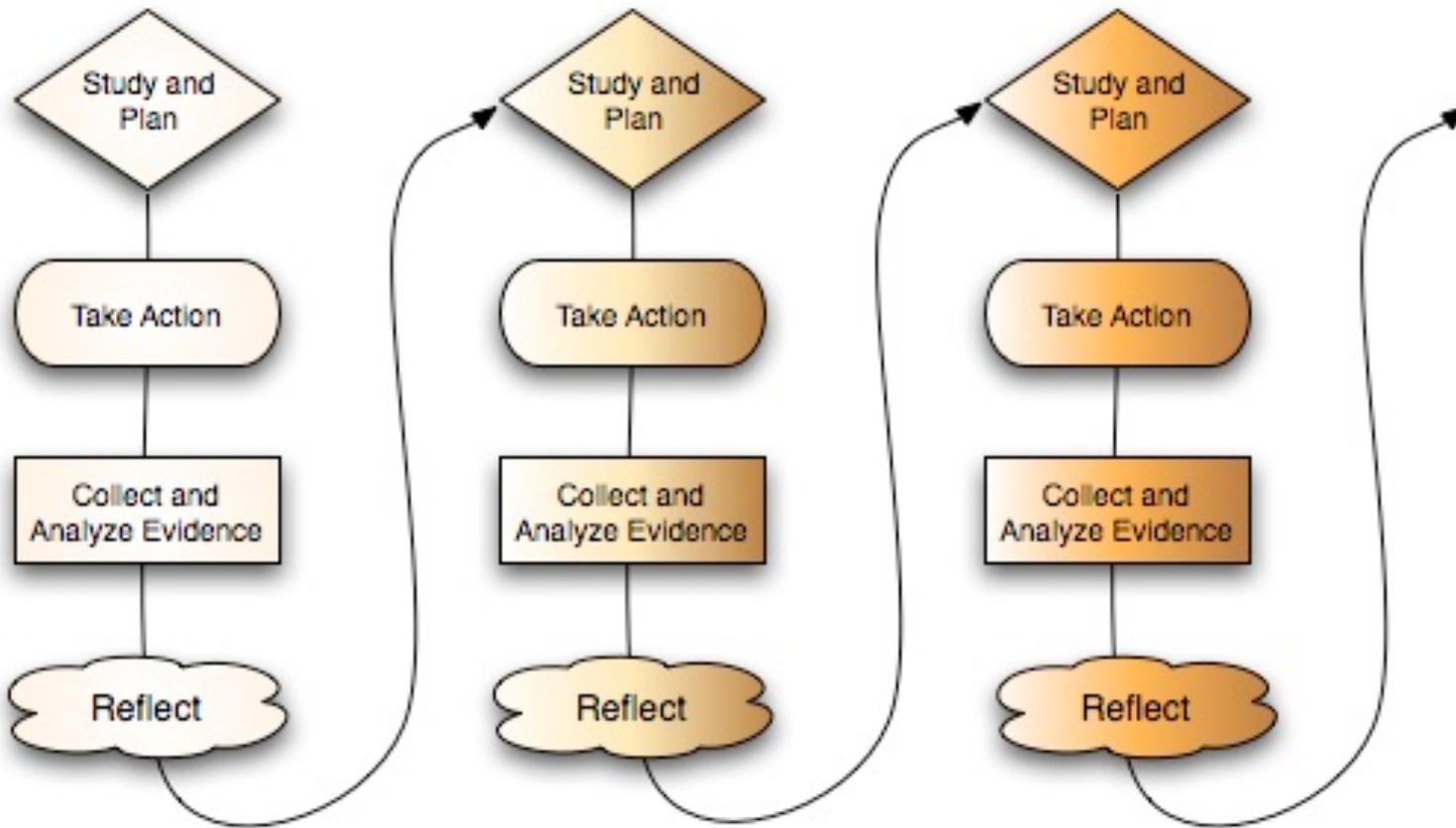
- 8 middle school and secondary mathematics teachers
 - 1-11 years of experience
 - Toronto-area public and independent schools
- 4 researchers

■ Activities: Action Research

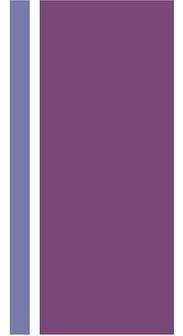
- Monthly meetings
- Wiki
- Research

+ Action Research

<http://cadres.pepperdine.edu/ccar/define.html>

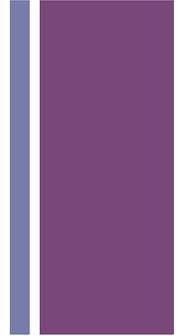


+ Defining equity



- Indigo's introduction: Equitable teaching...
 - Provides (marginalized) students access to deep mathematical ideas, ways of reasoning
 - Provides (marginalized) students access to positive mathematical identities that don't conflict with their personal identities
 - Challenges oppression within and outside the school (e.g., anti-racist, anti-homophobic, anti-genderist, etc.)
- Cochran-Smith's 6 principles of teaching for social justice

+ Narrowing our focus



- Silent brainstorm
 - Defining key terms
 - Identifying equity issues
 - Coming up with research questions
- Small groups develop
 - Research, planning
 - Individual projects
- Projects changed along the way...
 - Unexpected challenges, opportunities



+ Helping students persevere
and maintain interest in math

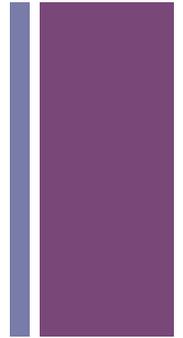
Lisa

+Teacher Inquiry

Working collaboratively we identified common areas of concern

We noticed that:

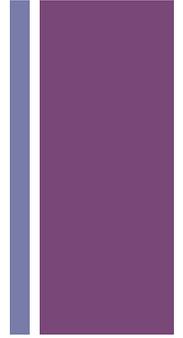
- students give up easily when working
- lack of interest/engagement with math problems



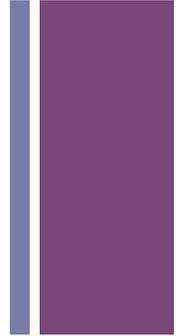
+ Developing the Question

Looking at my students, I wondered:

- Do social justice issues play to middle school students ?
- Will working in a group provide support and see students persevere?
- What kind of activities and pedagogy improve student motivation and perseverance in a middle school class?

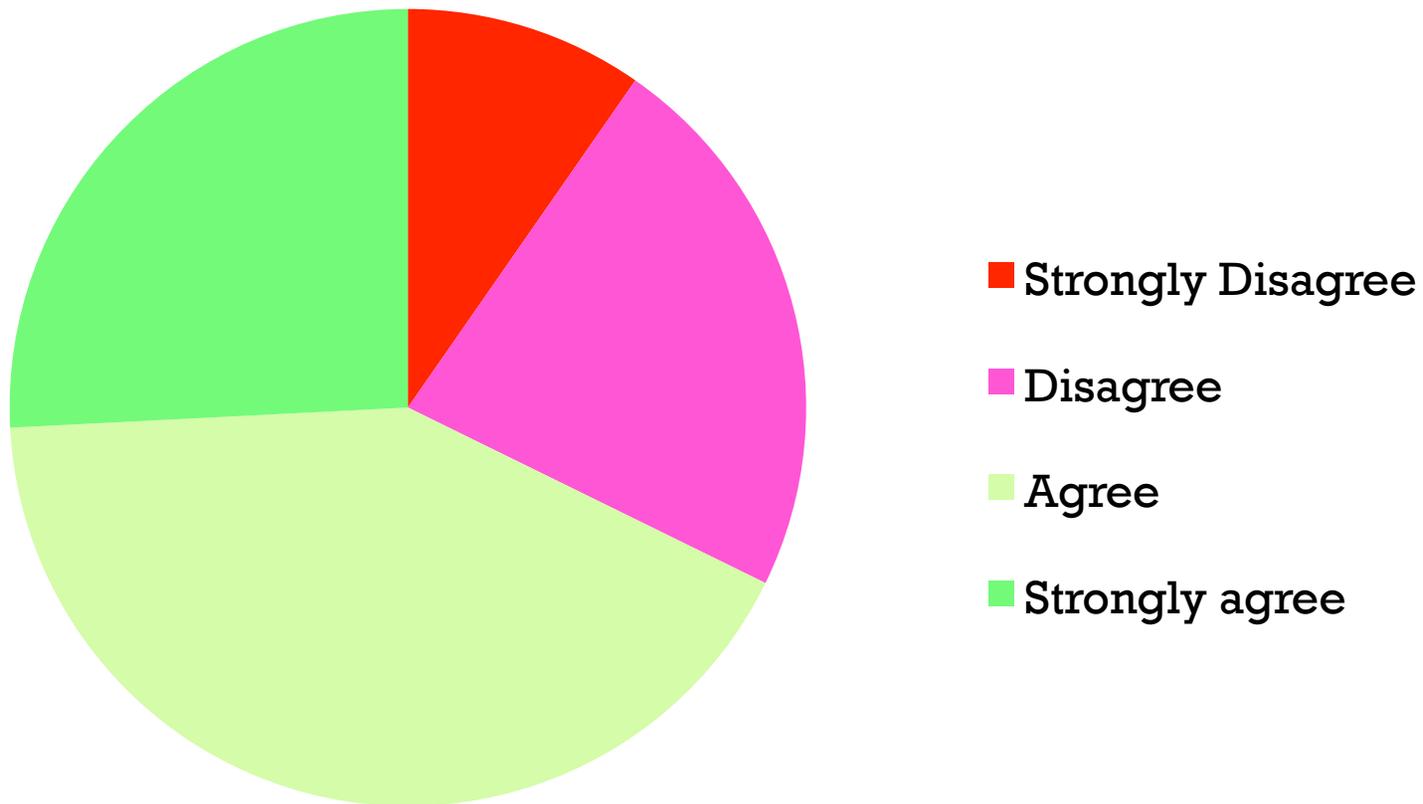
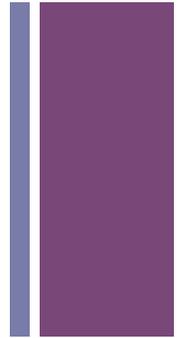


+ Baseline Data

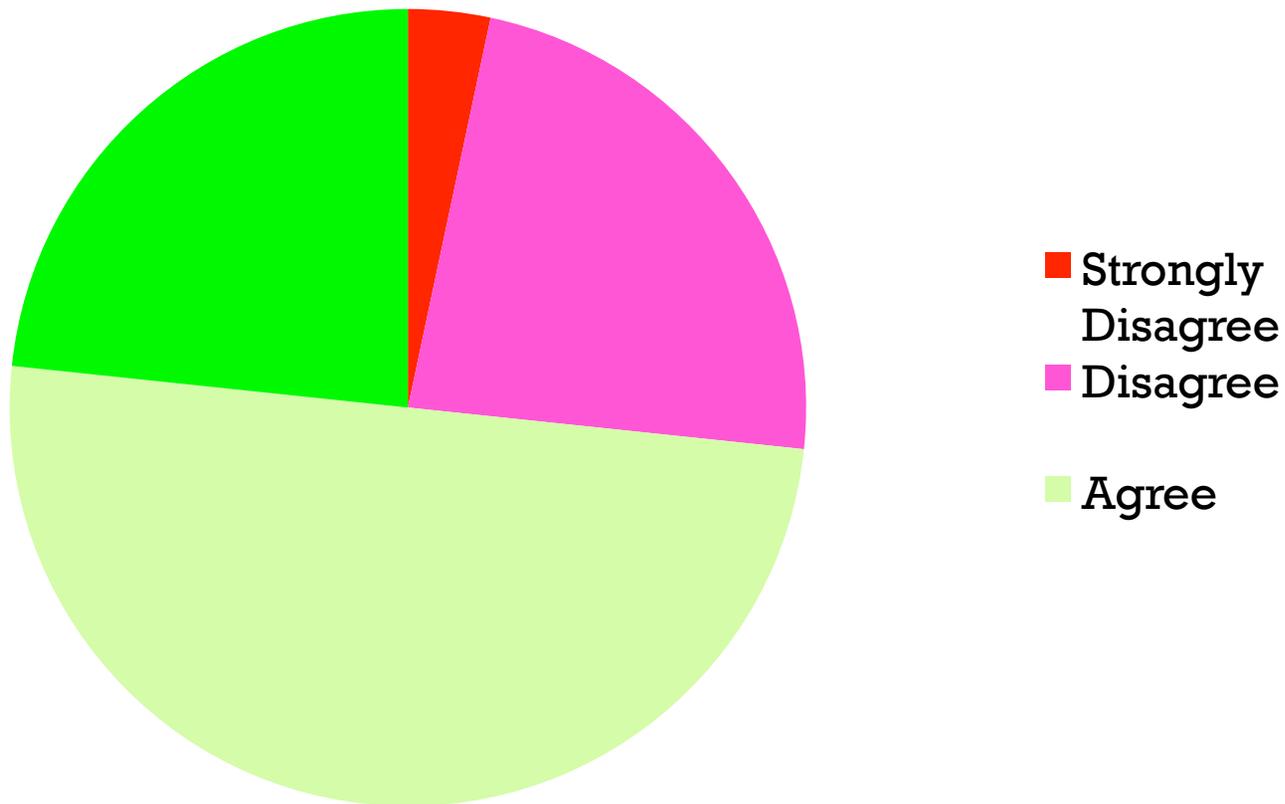
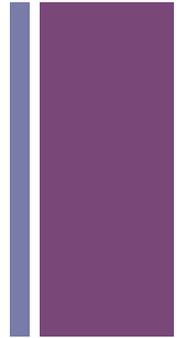


- Attitudinal survey
 - Very broad: student feelings towards math group work and the ways they could see success
 - Used Google docs to put the survey online
- Maybe too much data
 - Focused in on the idea of learning with and from other students

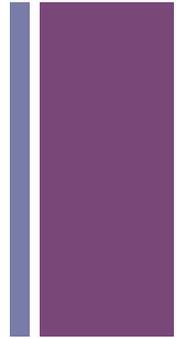
+ I learn the most in math class from working with other students.



+ A really good way for me to understand an idea in mathematics is to explain it to someone else

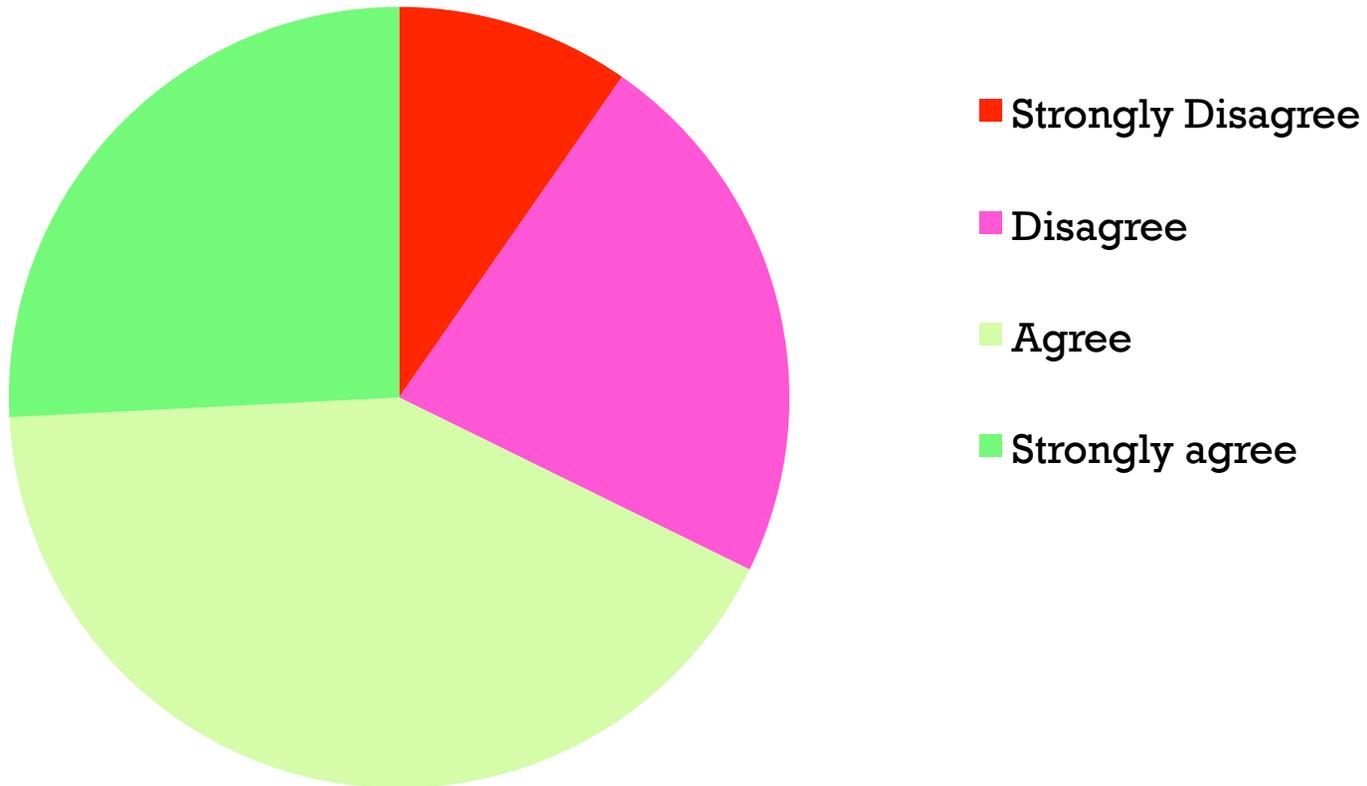
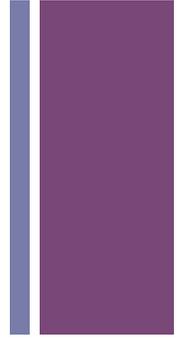


+ A really good way for me to understand an idea in mathematics is to have another student explain it to me.



- Strongly Disagree
- Disagree
- Agree
- Strongly agree

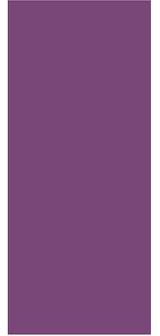
+ A really good way for me to understand an idea in mathematics is to apply it to a real-world problem.



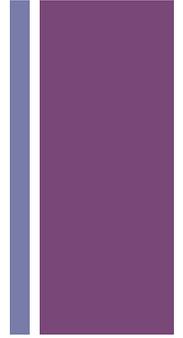
+ Developing the Tasks

Criteria:

- Review of area and volume
- Do-able in an 80 minute class
- Be completed over a two week period
- Be group work (with a partner or in a group of 3).
 - Activity 1: Shrinky Dinks
 - Activity 2: Too Close for Comfort
 - Activity 3: Rolling Rectangles



+ How is Social Justice Addressed



In all activities:

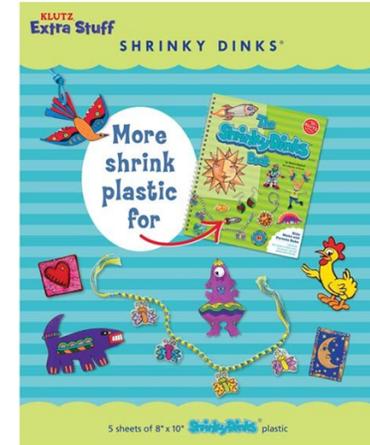
Cochran-Smith Principles of Social Justice

Principle 1: Enable significant work within communities of learners

In Too Close for comfort:

Principle 6: Make inequity, power and activism explicit parts of the curriculum

+ Shrinky Dinks



- Groups review area formulae for different shapes.
- Using formulae, calculate area of a polystyrene shape before and after shrinking.
- Determine percentage of shrink.
- Predict final size of a self designed piece.

+ Rolling Rectangles

- Students roll paper into two different shaped cylinders
- Same surface area, different volume (a discrepant event)



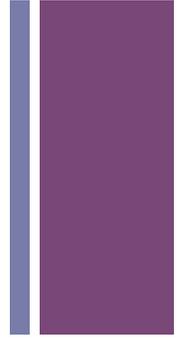
+ Too Close for Comfort



From Math that Matters by David Stocker

- Learn about space use in refugee camps and homeless shelters
- Learn about spread of disease in crowded spaces
- Design a homeless shelter and determine the number of beds it could accommodate.
- Compare the amount of living space in average homes in different areas of the world, with shelters/camps

+ Student Reflections on 'Too Close for Comfort'

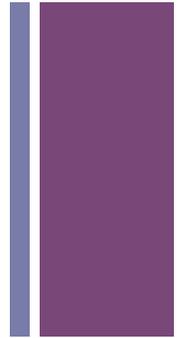


- An emotional response: surprised and saddened
- Enjoyed working with a new partner
- Group work
- Appreciated looking at real issues with math.

"It opened my eyes the number of homeless people that actually are in Canada."

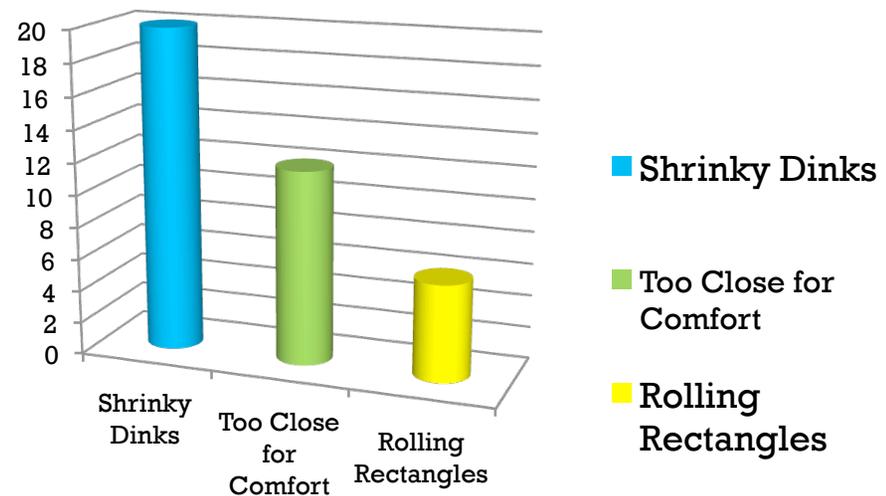
I think that 'Too Close for Comfort' should be used for next year because it gives children a glimpse into the real world and how math is really used."

+ The Final Reflection: Recommendations for Next Year



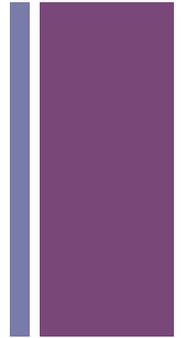
- 30 respondents
 - 25 students recommended one activity
 - 2 recommended 2 activities
 - 3 recommended all 3

- 20 Shrinky Dinks
- 12 Too Close for Comfort
- 6 Rolling Rectangles



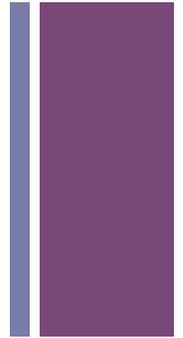
+ Group Work

- Survey and reflections suggested that group work was a way to help improve learning and engagement
- Some students expressed concerns about working in a group
 - not liking who they were working with
 - feeling like their ideas got lost in the group
 - group members who didn't pull their fair share

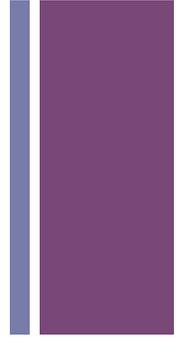


+ Next steps...

- Bring this data back to the class and have them work out....
- How can we be good group members and get more from group work



+ Changing Practice



- Working on developing group work skills
- Including more social justice type activities
- Support aspect of teacher inquiry project
- Time to do teacher inquiry



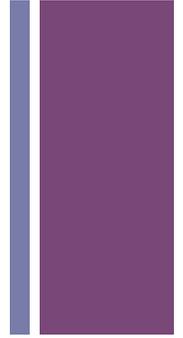
+ A problem with problem-solving

Beth

My Math Class at The Linden School



+ A Problem with Problem-Solving



- The girls in my class, as research often shows that girls do, displayed “learned helplessness” when confronted with challenging problems.
 - solving word problems requires higher-order thinking skills that not all students have attained
 - understanding word problems requires reading skills as well as math skills

Equity:

Some of the Key Goals I Aim For

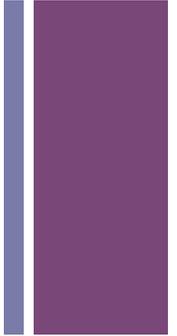
Girls should have equal access to knowledge and skills in math, including enjoyment and confidence.

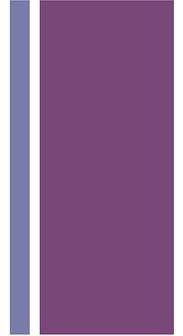
Every member of class, regardless of ability or learning style, should be given opportunities to develop mathematical skills.

Math skills should be used to understand and address inequity in the world.

+ Action Research Question

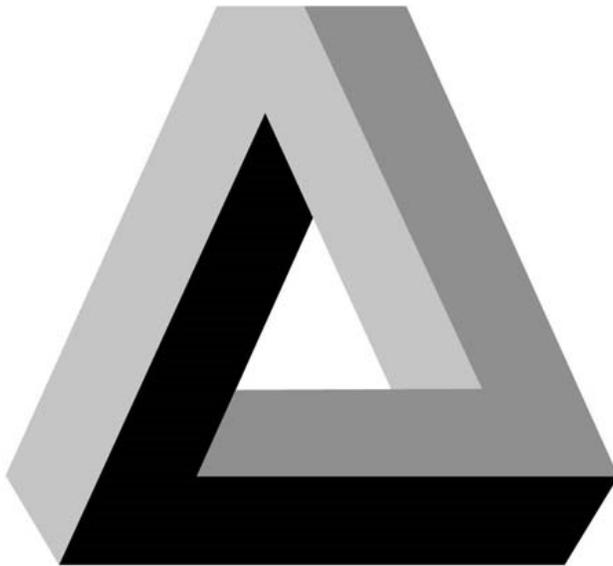
- What types of **problem-solving contexts** will allow my students to gain confidence and competence as independent problem-solvers?





- **Participation:** Which students actively attempt to solve each problem?
- **Success:** Are their solutions accurate?
- **Attitude:** Do they feel confident, interested, and successful?

First Problem-Solving Context: Collaborative Experiment



- A Triangle has an area of 20 square centimetres. In how many ways can you make this triangle?

Second Problem-Solving Context: A “Real-Life” Example



■ You are designing a new rectangular carpet for the classroom! There are a few rules:

- Your design needs to include some triangles, but not only triangles.
- The total area covered by triangles should be no less than one-fourth of the total area of the carpet, and no more than one-half the total area.
- You need to cover a total area of 100,000 square centimetres.

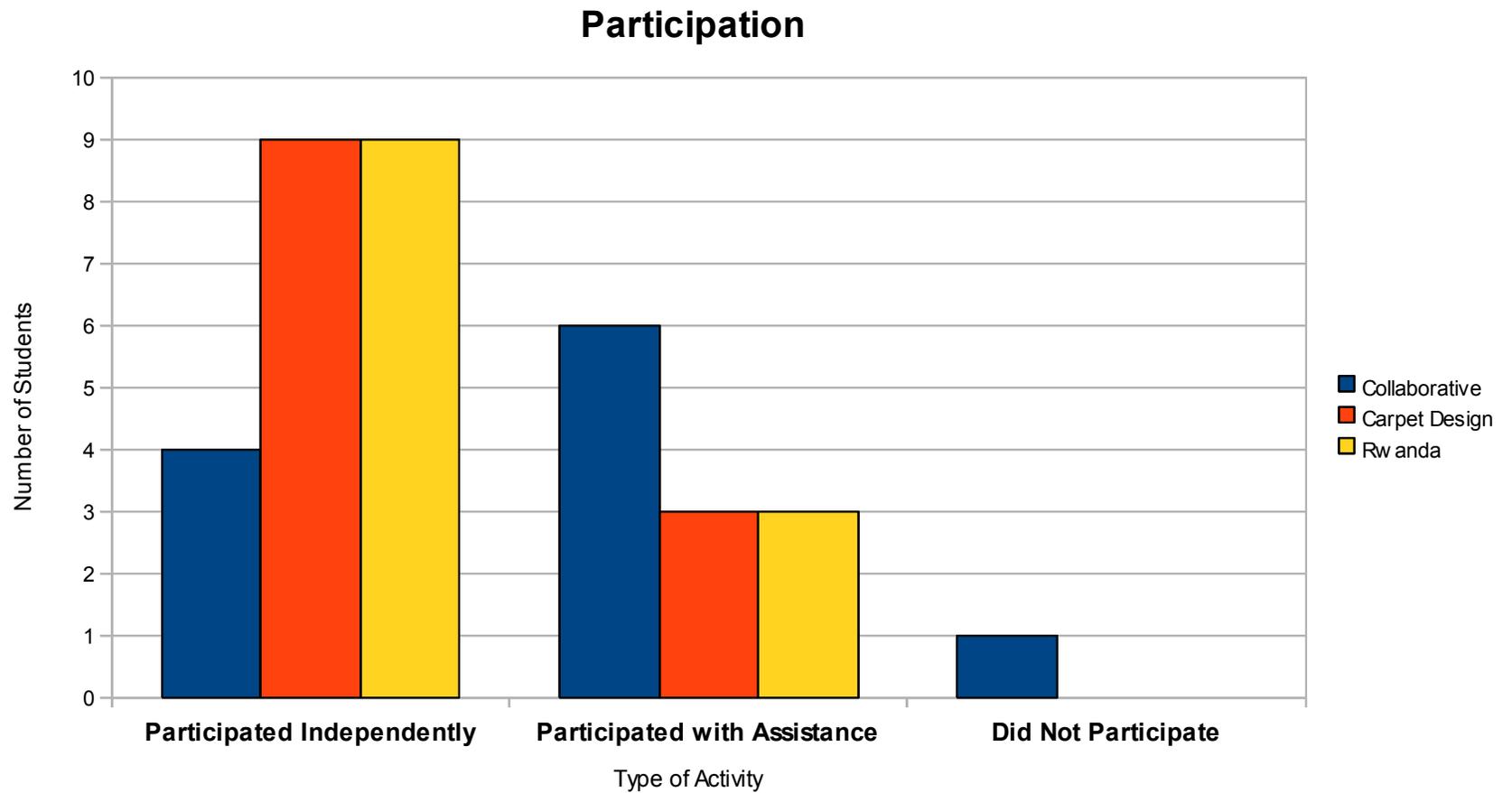
Third Problem-Solving Context: A Social Justice Example



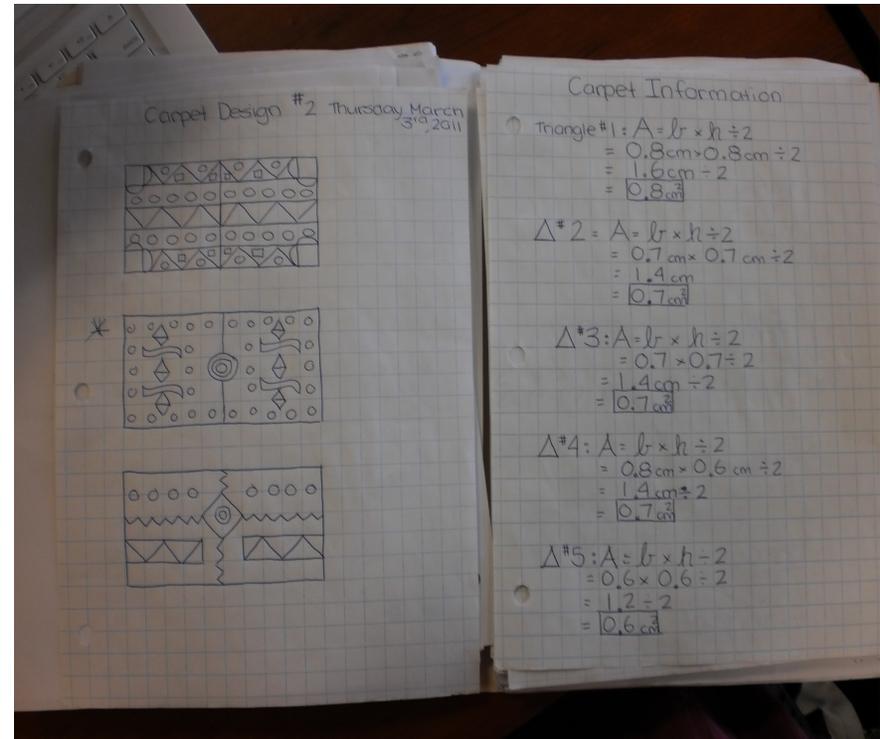
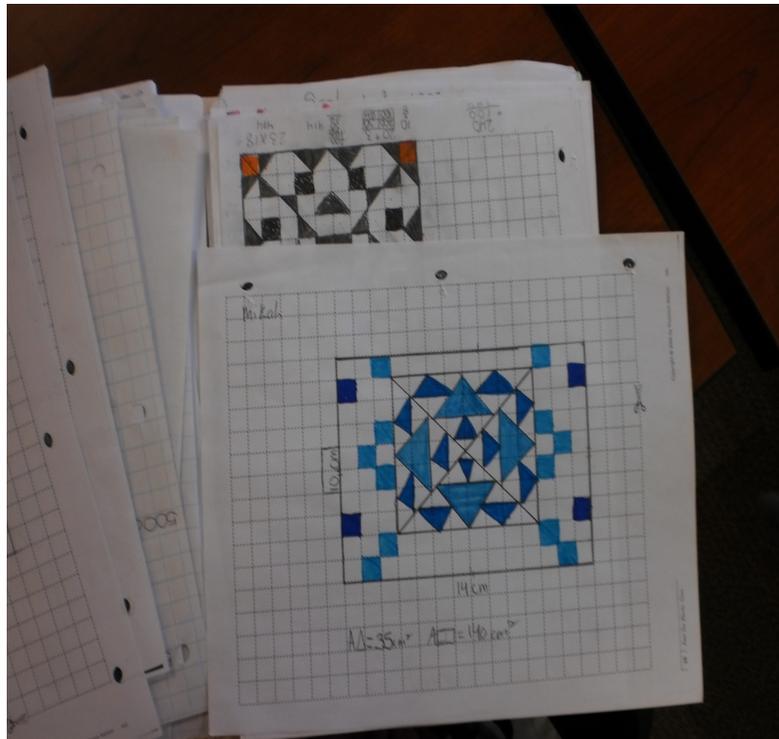
Land Inheritance in Rwanda

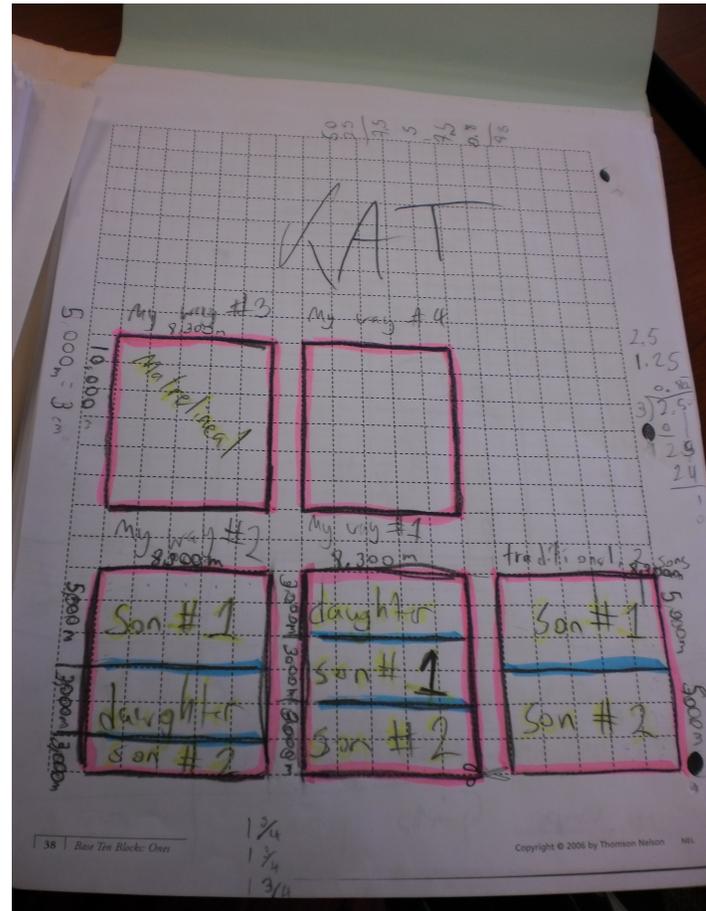
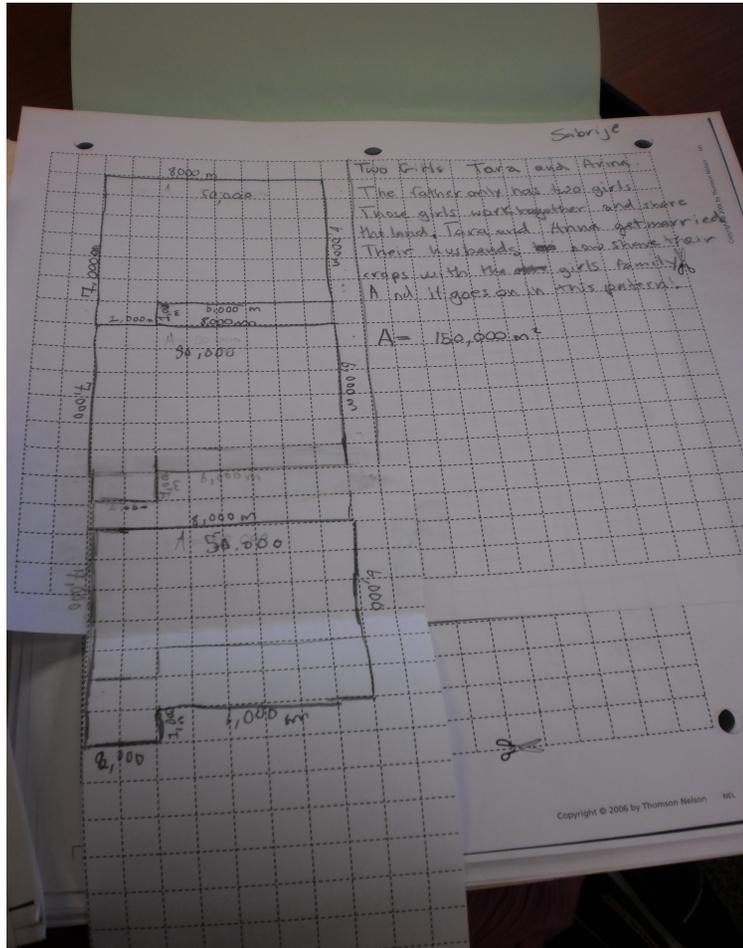
Problem: It takes about 5000 square metres of farmland to feed a person for a year. A father has 50 000 square metres and three children: two boys and one girl. How should he pass down this land to his children? Come up with two possible solutions (which need to be different.)

Data: Did Students Participate?



Data: Were Students Successful?





Data: How did students respond to the survey?

#2

Problem-Solving Survey:

Did you feel confident about solving this problem? (Please check one)

1 Yes, right after I read the problem.
 2 Yes, as soon as I asked Beth questions about it.
 3 Yes, after working on it for a while.
 4 Yes, after I talked about it with people around me.
 5 I felt both confident and unsure about solving the problem.
 6 No, I did not feel confident about solving this problem.

Did you enjoy working on this problem? (Please check one)

Yes.
 Not at first, but later I did.
 In the beginning, but not at the end.
 No.

How did you feel about seeing other students sharing their solutions at the end of class? (You can check more than one.)

I found it gave me new ideas.
 I found it helped me understand the problem better.
 I found it confusing.
 I really liked sharing my own ideas.

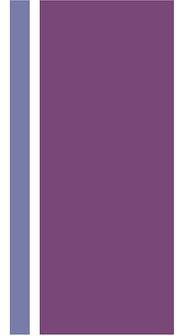
What kinds of problems do you like solving best in math class? (Please try to rank these with number one as your favourite.)

Problems that Beth makes up about silly things.
 Problems that are about Linden, or our class.
 Problems that are about real issues in the world.
 Problems from the textbook.
 Problems that are only about numbers, and not other things.
 Gosh, I hate problems!

Anything else you'd like to say?

not really
I LOVED THIS ONE

+ Most interesting finding:



- **Top choice after Carpet Design activity:**
 - “My favourite type of problem is silly things that Beth makes up.”
- **Top choice after Rwandan Land Inheritance activity:**
 - “My favourite type of problem is about real issues in the world.”
- *(Textbook problems consistently ranked among students least favourite types to solve.)*

The ^{eldest} daughter would get half the land when she got married. Then the ² eldest sons would get a quarter. Then the eldest daughter would be responsible for 1 person in one of the sons family, when the ^{eldest} son passed down the land to the eldest son.

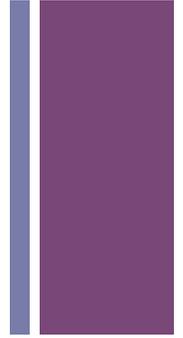
land is given to	12 500	given to the eldest daughter when her daughter has one son	25 000 m
or if she have one closest	12 500	she's married doesn't give it to her	25 000 m
eldest son	12 500	she will give it to her	25 000 m
Bob	10 000	she will give it to her	25 000 m

Then the eldest daughter will share that land with her husband children and 1 person from her family. Then the sons will give the land to their eldest child. If they want they can sell the land.

1000 = 10000m

$$\begin{array}{r}
 25000 \\
 12500 \\
 \hline
 37500
 \end{array}$$

+ What I Learned



Open ended = most engaging

Choose SJ topics with students in mind

Be prescriptive about the “math” you want done

Teaching Theoretical Algebra

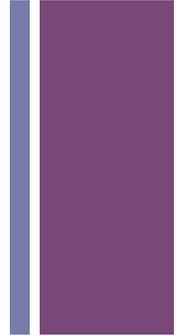
+

Yes it's social justice!

Kaya and Michelle

+

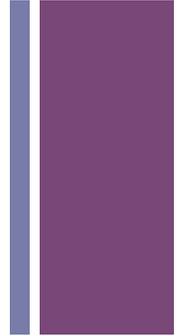
Research Questions



How can abstract algebraic concepts be taught so grade 11 students are receptive to them and master them?

How can investigation be used in a more authentic way?

+ Principles of Teaching for Social Justice Identified



Principle 1: Enable significant work within communities of learners

Principle 2: Build on what students bring to school with them – knowledge and interests, cultural and linguistic resources

Principle 3: Teach skills, bridge gaps

Cochran-Smith, M. (2004). *Walking the Road: Race, Diversity, and Social Justice in Teacher Education*. New York: Teachers College Press.

+ Curriculum Expectations Identified

- Problem-solving: develop, select, apply, compare, and adapt a variety of problem-solving strategies as they pose and solve problems and **conduct investigations, to help deepen their mathematical understanding**

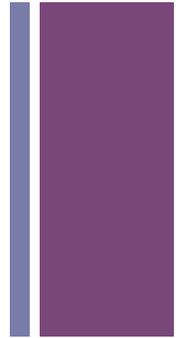
- simplify radicals and radical expressions

$$(2 + \sqrt{6})(3 - \sqrt{12})$$

- simplify rational expressions

$$\frac{2x}{4x^2 + 6x} - \frac{3}{2x + 3}$$

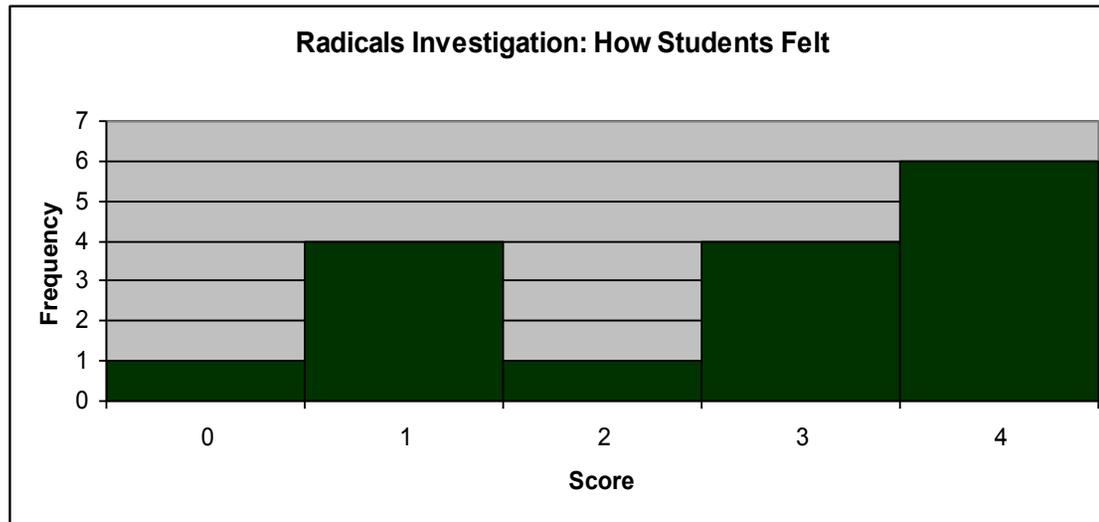
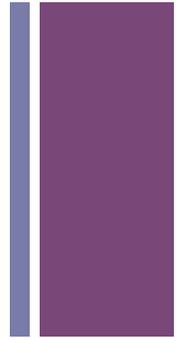
+ Overall Model for Both Activities



1. Groups formed (random, mixed ability)
2. Pre-requisite skills reviewed in groups
3. Learning Activity in groups
4. Exit cards (skill assessment and feedback)

+ Theoretical Algebra Topic	Learning Activity Strategy	Example
Simplifying Radicals	Unstructured group-investigation	<p>How can you show the left side equals the right side without using a calculator?</p> <p>a) $\sqrt{6}\sqrt{2} = 2\sqrt{3}$ b) $\sqrt{12} + \sqrt{27} = 5\sqrt{3}$</p>
Simplifying Rationals	Textbook example-based group approach	<p>Multiply these rational expressions:</p> <p>a) $\frac{9x^2}{2x} \times \frac{12x^3}{3x}$ b) $\frac{10a^2b}{3a} \times \frac{15a^3}{12b^2}$</p>

+ Unstructured Group Investigation of Radical Rules



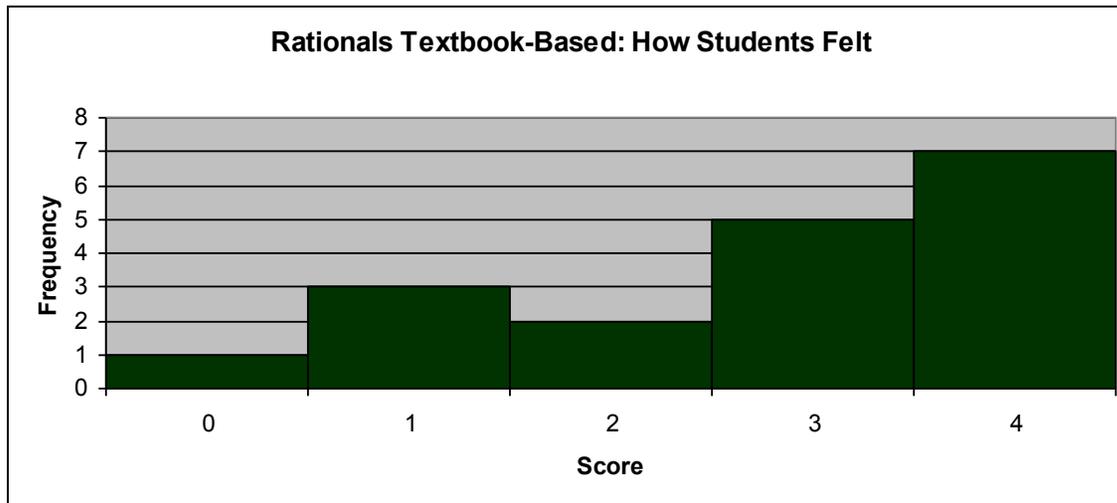
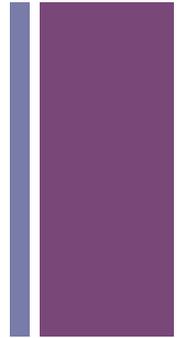
"I really like it. We were explaining to each other and I think that we can explain in more easy and simple form, so it's helpful."

Exit Card Results
average mark: 64%

→
Teacher-centered review

Test Results
average mark on this topic: 73%

+ Textbook Example Based Group Approach to Rational Rules



“A lot more interesting than the regular class. We got to talk to people instead of just watching the board.”

Exit Card Results
average mark: 56%

→
Little teacher-centered review

Test Results
average mark on this topic: 49%

+ More Student Thoughts on the Activities

Feedback on the Unstructured Investigation-based

"good to work together and learn by ourselves"

"good activity. Group work can help share opinion ... but sometimes group explanation isn't enough for the whole group to understand. "

"practiced more because not confident because no lesson"

"prefer lesson (more straightforward and easier to understand). Had to spend time on own to understand group work. Interesting how people think differently in groups."

Feedback on the Textbook Example-based

"easier than normal"

"there was no lesson, just group work and I thought that it was pretty good because each person understood some parts in doing the question which really helped us understand, but I think a tiny lesson would have been helpful, ... overall, working in groups also really helped prepare us and practice."

"actual lesson would be more effective...with detailed notes... An investigation, although a hands on experience doesn't have the amount of detail as a lesson and should be given after the lesson."

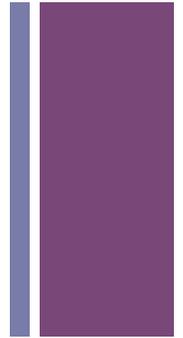
+ Lessons Learned and Next Steps

Students enjoyed working in groups but did not master the algebraic concepts.

Radical rules game: students determined how to simplify radical expressions while working on the board supported by their group. Students were able to ask questions and experiment with teacher support. Teacher was able to provide more immediate feedback so correct rules were established by the groups as the expressions became more complicated.

Conclusions:

Some theoretical concepts cannot be “discovered” without scaffolding or opportunities for immediate teacher feedback. Meaningful activities should be developed that value students’ own understanding, and this understanding should be used in the discovery process in a mediated way.

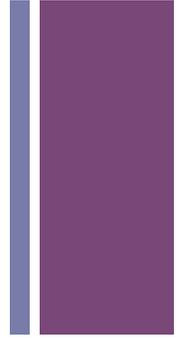




+ How do Gr. 12 'college-bound' students respond to social justice activities?

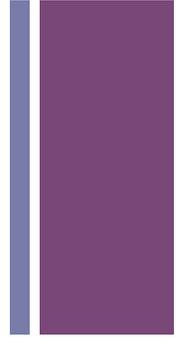
Matt

+ **What is the relationship between perceived race and student performance?**



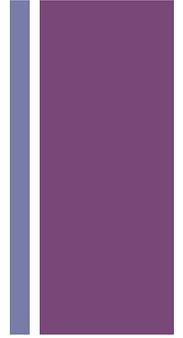
- The project was incorporated into the statistics unit focusing on two variable statistics
- Designed to span four 75-minute lessons

+ My Goals



- Facilitate an engaging conversation around discrimination with a focus on race
- Have students motivated to do math through a social justice lens
- Increase the number of completed assignments

+ Cochran-Smith Principles of Social Justice

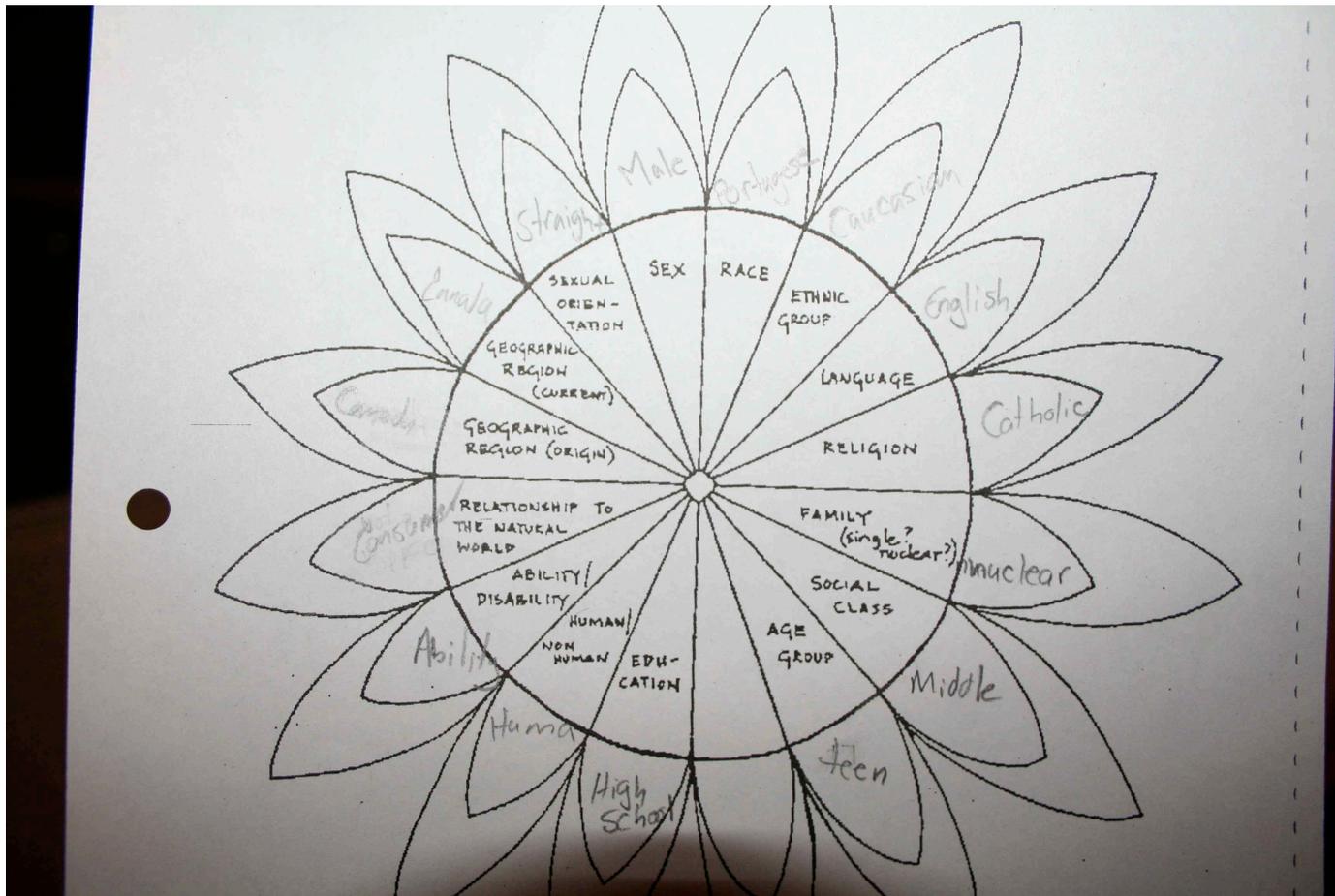


Principle 2: Build on what students bring to school with them – knowledge and interests, cultural and linguistic resources

Principle 6: Make inequity, power and activism explicit parts of the curriculum

+ Started with an open discussion on power and discrimination

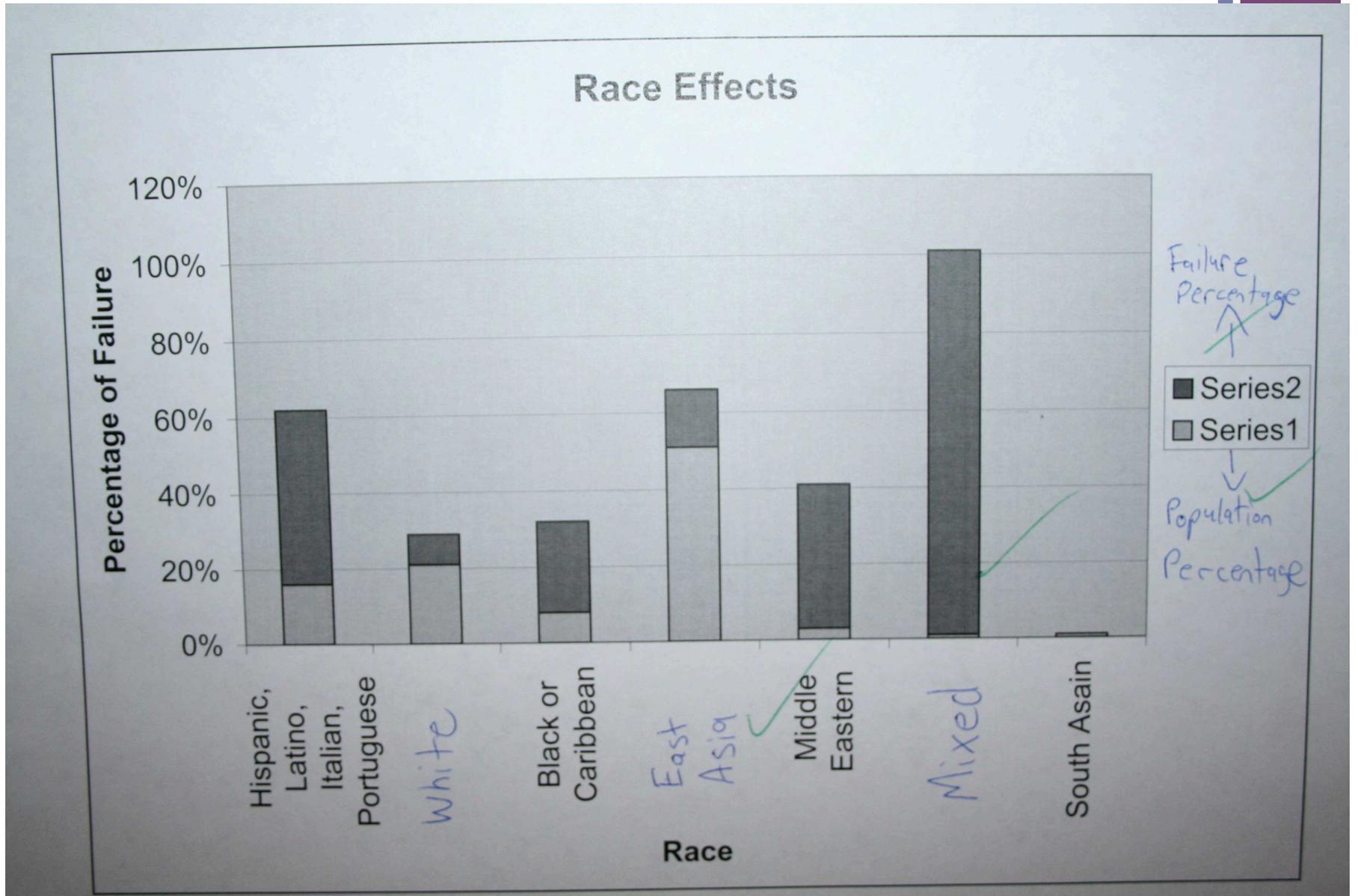
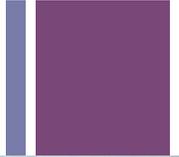
Completed "Power Flower" activity as a class



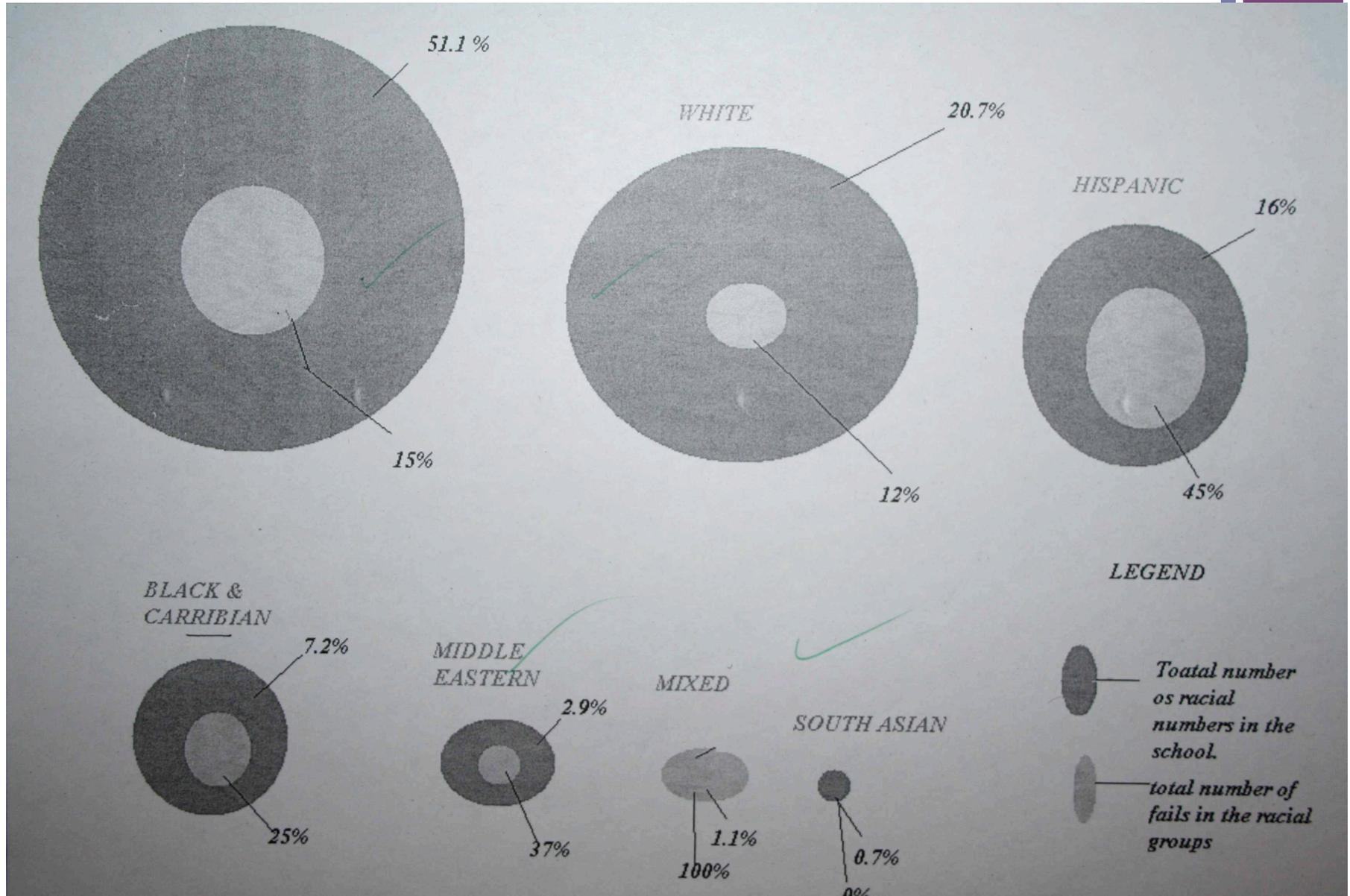
+ The data was interpreted and summarized.

Racial Group	Sample Size	Student Failures	Percentage
Large Group (Sample size is greater than 10 students)			
Hispanic, Latino, Italian	44 ^{16%}	20	45% ✓
White	57 ^{20.7%}	7	12% ✓
East Asian	141 ^{51.1%}	21	15% ✓
Black	20 ^{7.2%}	5	25% ✓
Small Group (Sample size is less than 10 students)			
Middle Eastern	8 ^{2.9%}	3	37% ✓
Mixed	3 ^{1.1%}	3	100% ✓
South Asian	2 ^{0.7%}	0	0% ✓

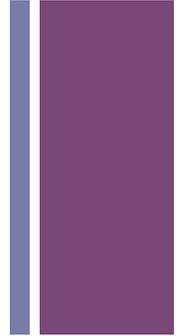
+ Some student work...



+ Some student work...

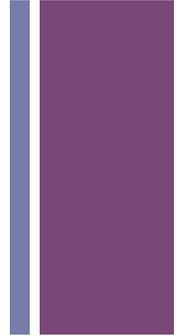


+ Observations



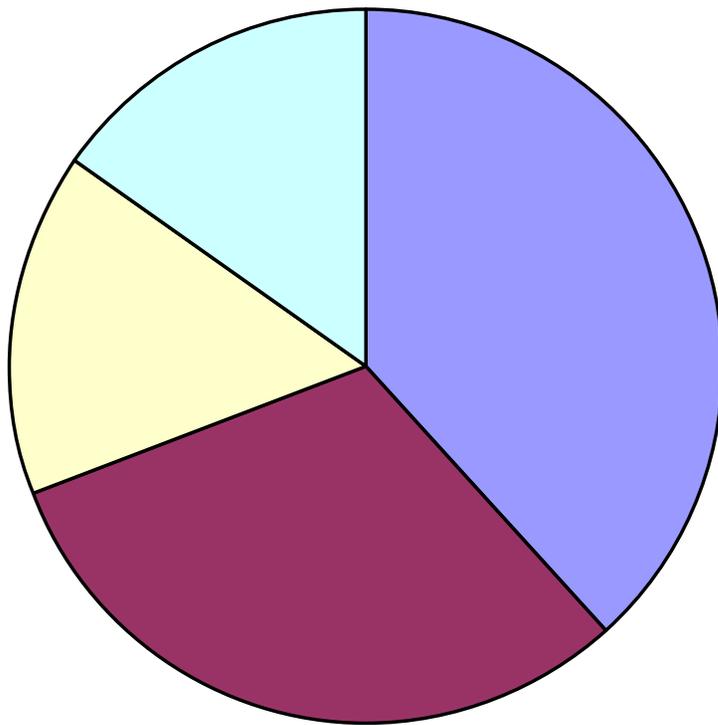
- 50% of the students submitted a completed project
 - The project actually spanned 3 weeks due to scheduling
- This was comparable to other projects assigned in class.
- Different students completed this project, compared to other assignments.

+ Observations



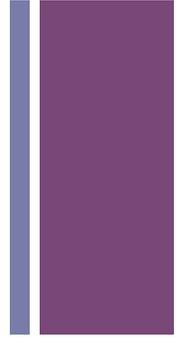
- An exit interview was conducted to measure the students' opinions on the effectiveness of the project.
- This consisted of a free write and a one-on-one interview.

Q1: When you observe this data, what sort of thoughts went through your head?



- Not surprised by the data
- Believe race should not affect performance
- Have negative feelings towards the data
- Believe race does affect performance

+ Q2: How do you feel this activity compares with the more traditional math activities?



Student Responses

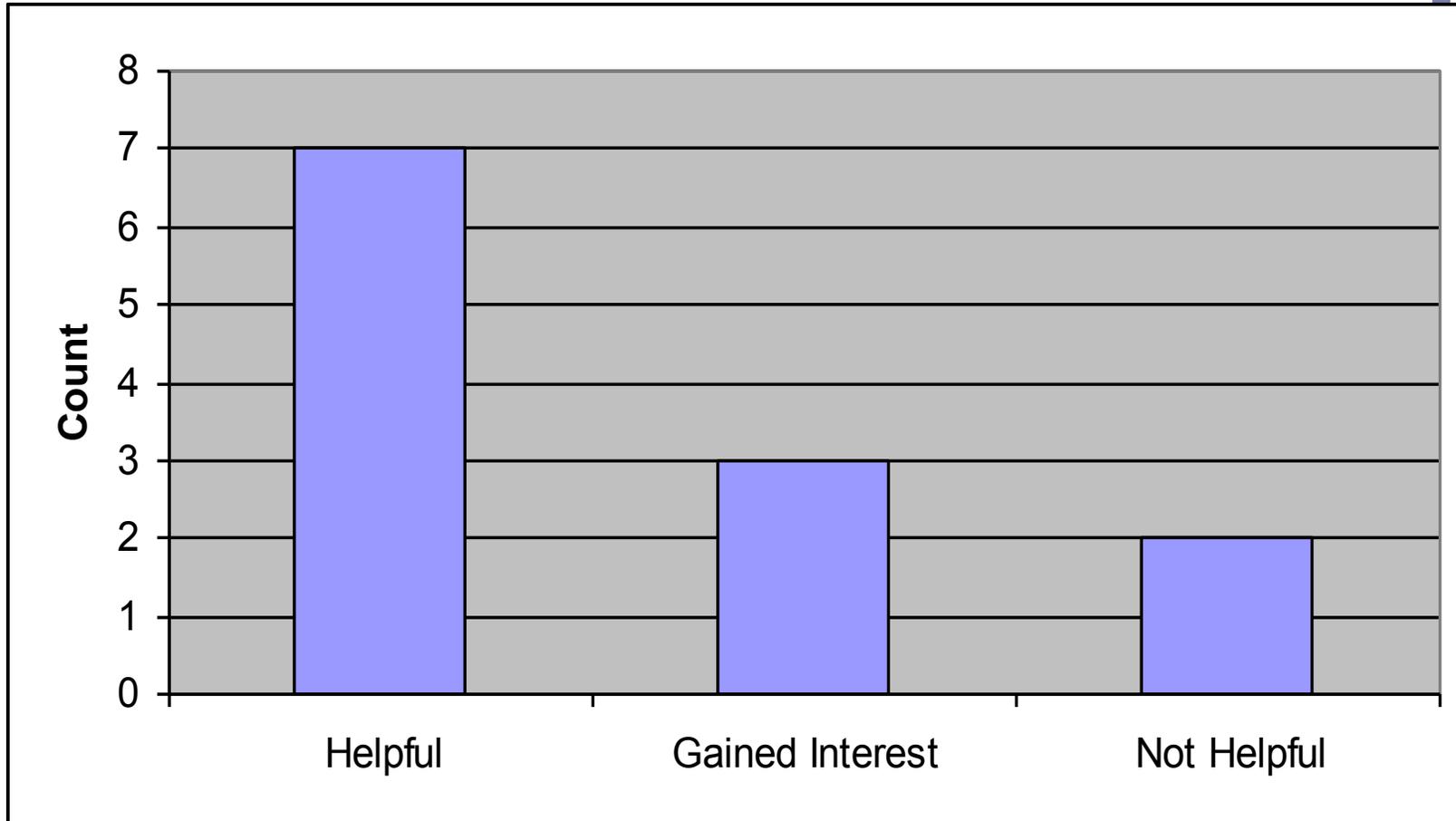
“Better, made the activity easier”

“More interesting”

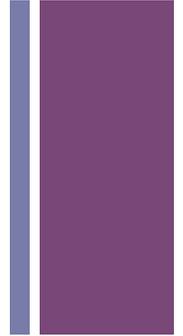
“Can apply math to something relatable/useful”

“Would prefer to do math problems”

+ Q3: Do you think this sort of activity helped you learn more about statistics?



+ Implications for next time



- Establish clear deadlines and create checkpoints for completion
- Tasks need to be achievable in one class; multi-day tasks lost effectiveness
- Extend the lesson beyond the classroom, incorporate social action into the project



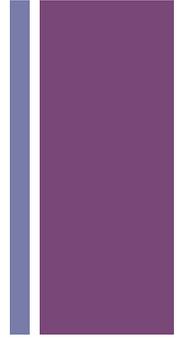
+ Looking at issues of student
engagement in mathematics

Krissy

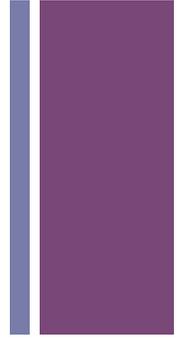
+ Developing the Questions

Looking at my students, I wondered:

- Why are my students more engaged in science class?
- How could we co-create a more engaged classroom environment?

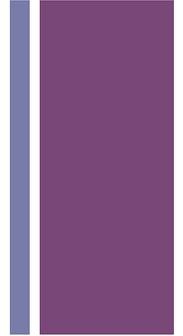


+ Implementing the Project



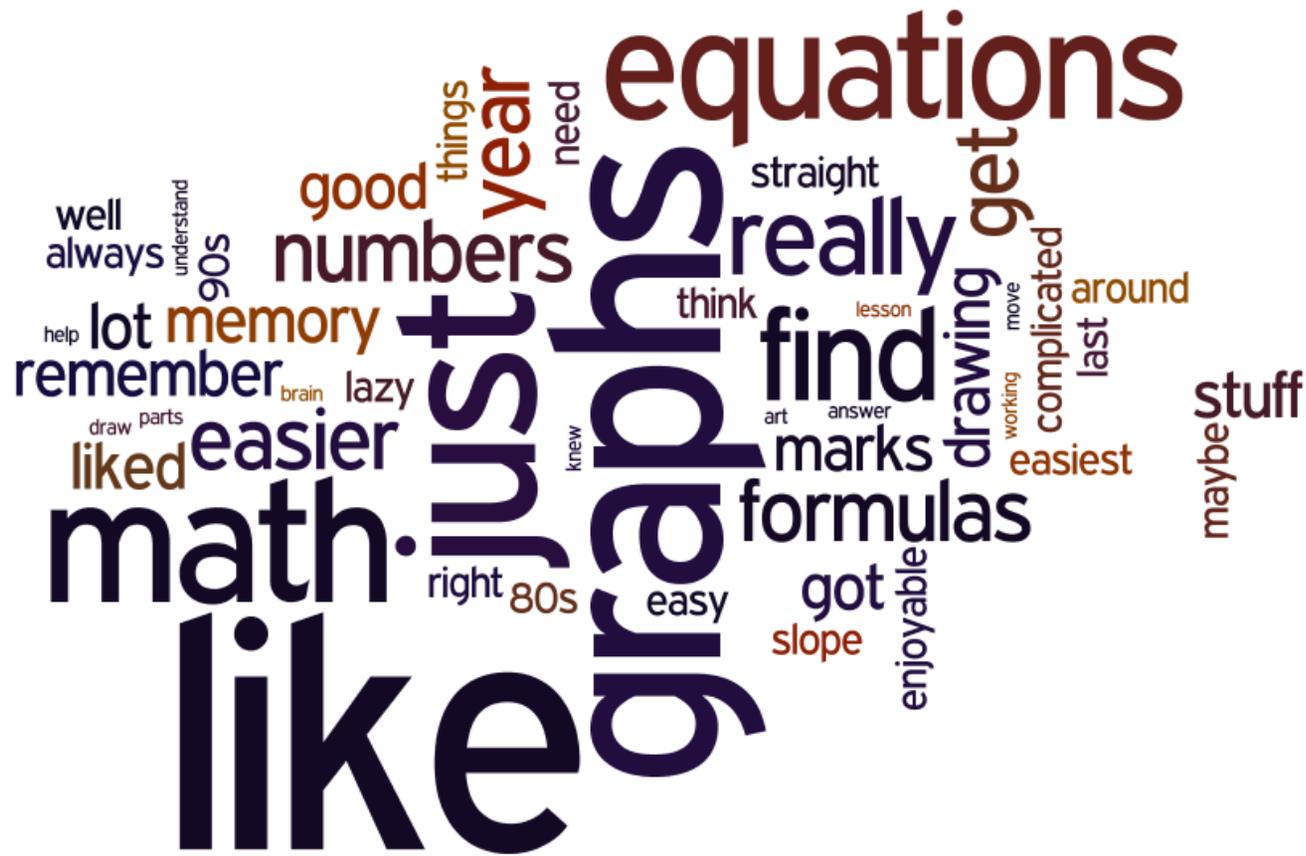
- My students loved to talk, so I played to that strength!
- Open invitation to one of my grade 9 math classes to come in for a focus group.
 - Four male students came in (and got a free lunch!)

+ How Social Justice is Addressed...

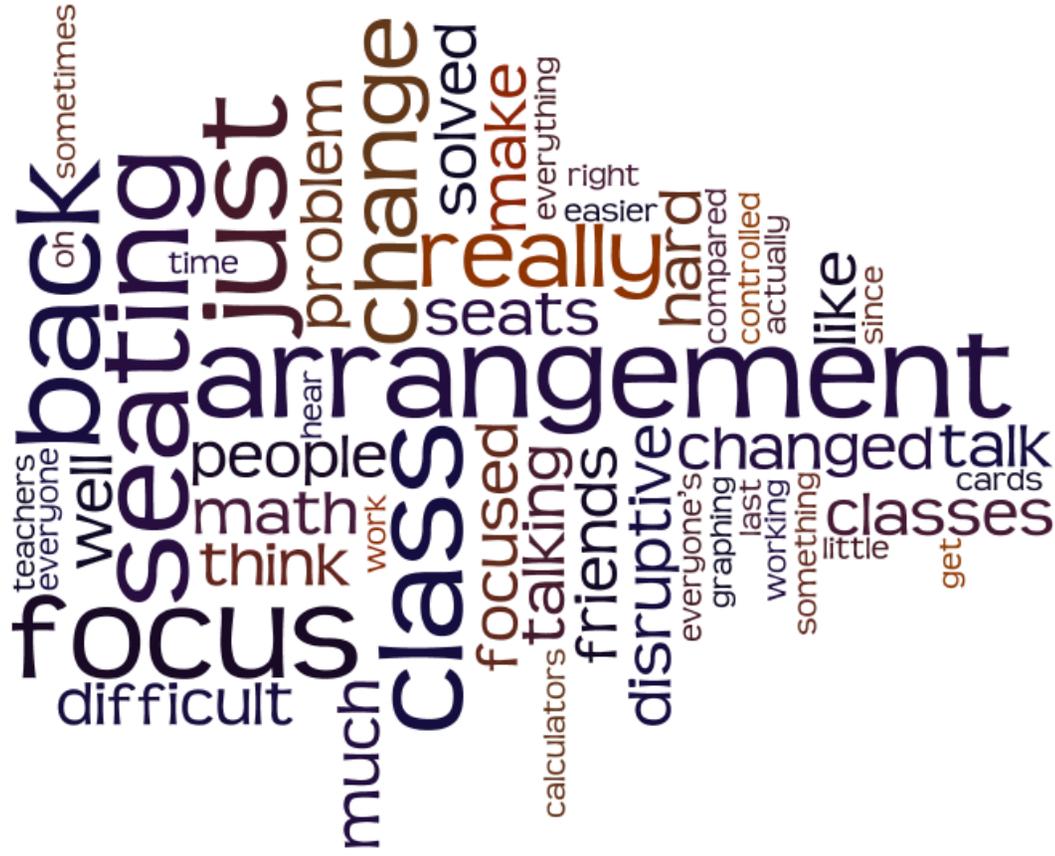


- Principle 2: Build on what students bring to school with them – knowledge and interests, cultural and linguistic resources.
- Principle 4: Work with (not against) individuals, families and communities.

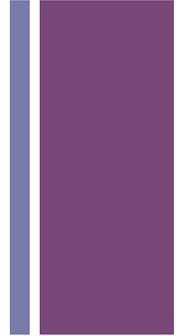
+ Prompt 2: When you enjoy math class, what is going on in class?



+ Prompt 3: What is not working for you in our math class?

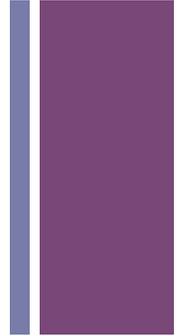


+ What I Learned



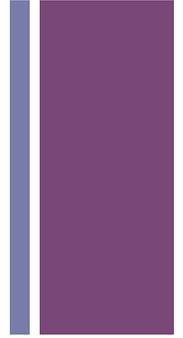
- Students want to have interaction with their teacher.
 - “I think maybe if you did math activities where you could interact with the entire class, we’d get excited about that and focus more.”
- Students want visuals.
 - “We have the overhead and it is visual, and it makes it more fun, the visual part. Maybe if you could use a SmartBoard to teach, that would definitely get my attention a lot better towards the subject.”

+ What I Learned



- They want more activities.
 - “More activities that involve everyone else would be easier. Teachers don’t do it that much, but when they do, it becomes more interesting.”
 - “Maybe experiments with math, like with probability. Last year, we used to play a game with dice and how many times you would get that number. That was really fun.”

+ Next Steps



- Get more opinions.
 - Focus group was only 4 students.
 - Try a survey at the start of the year as a baseline before I start doing activities.
- Series of interactive lessons that focus on a social justice issue that relates to the students.
 - Get feedback from students after several of these lessons.

+ Possible Social Justice Activity

- E-Waste recycling
 - Many students may not see it as important, but their cell phones don't cease to exist once they get a new one with more bells and whistles.

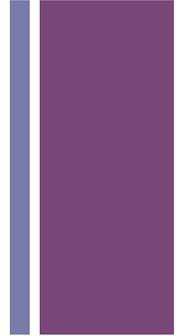




+ Benefits and Challenges of Action Research

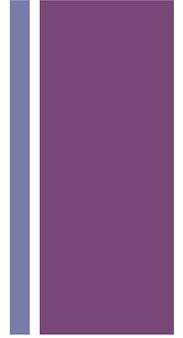
Indigo

+ Benefits of Action Research



- Motivation to...
 - Try new things
 - Collect evidence
 - Reflect
 - Take a new perspective on teaching and students
- Developing an action research community
 - Developing common questions
 - Supporting each other
- Modeling for students
 - Lifelong learning

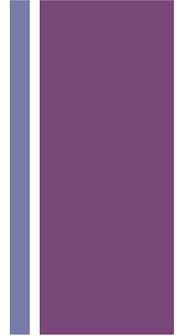
+ Challenges of Action Research



- Time
 - To plan, implement, reflect
- Risk
 - New approaches might not work out
- Unfamiliar research paradigm
 - Non-experimental
 - Ungeneralizable
 - Unrepeatable
 - Can't control many factors
 - Dealing with data
 - Too much data
 - Not the data you wish you had
 - How to maintain objectivity?

+ Your turn...

- Turn to your neighbor, and brainstorm some action research questions you might be interested in investigating with your classes.



+ Thank you!

- For more information, email Indigo at indigo.esmonde@utoronto.ca

