Guided-Inquiry Learning

in a Large-lecture Setting

Guang Jin, P.E., Sc.D.

Tom Bierma, MBA, Ph.D.

Environmental Health Program

Department of Health Sciences

The setting…

HSC 156, Environmental Health in the 21st Century (80-200 students per class)

The problem…

Abstract concepts disengage students

Examples:

- Development of pesticide resistance
- Bioenergy

Objective

- Increase student engagement, learning autonomy, and understanding…

- When presenting abstract concepts.

Guided-Inquiry Learning

Essentially the scientific process…

1. Recognize a problem, formulate a question.

2. Collect data

3. Examine data for patterns that help "discover" an answer to question.

POGIL

- Process-oriented Guided-inquiry Learning
- Originated in chemistry education
- Group process (downplayed in our work)
- Guided-inquiry process

POGIL

Premise…

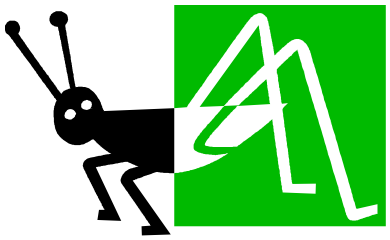
(supported by POGIL research)

Students are more engaged and have a better understanding when they are involved in inquiry and "discovery."

Clickers used to allow two-way communication.

Pre-test modules on small group

Module 1 Development of pesticide resistance



"How do pest populations become resistant to pesticides?"

"What are the implications for farmers?"

"How might resistance be minimized?"

Concepts to be "discovered."

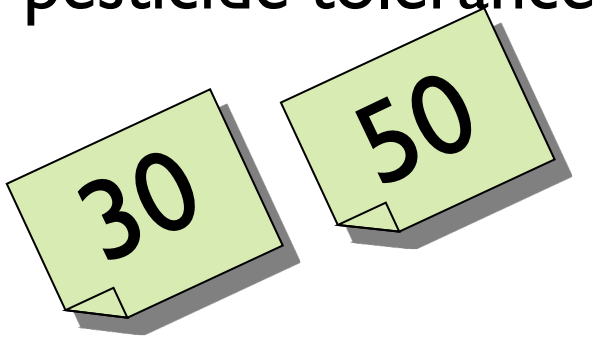
- Population resistance evolves from population diversity and stresses from the environment (pesticides)
- Rate of resistance development increases with pesticide application level.
- Pesticide application only buys time, doesn't solve problem.

Part 1 - manipulatives

- Use pieces of paper to create a pest population with diverse pesticide tolerances.
- Eliminate the susceptible individuals.
- Let the rest reproduce
- What do you discover?

Continuing….

- Let's assume you find two "pests" in your field.
- One has a "*pesticide tolerance*" of 30 and the other a pesticide tolerance of 50.
- A pesticide tolerance of 30 means that a pest cannot survive when pesticide is applied at a level of greater than 30
- Use a small piece of paper to represent each of these pests. Write their pesticide tolerance on the paper.

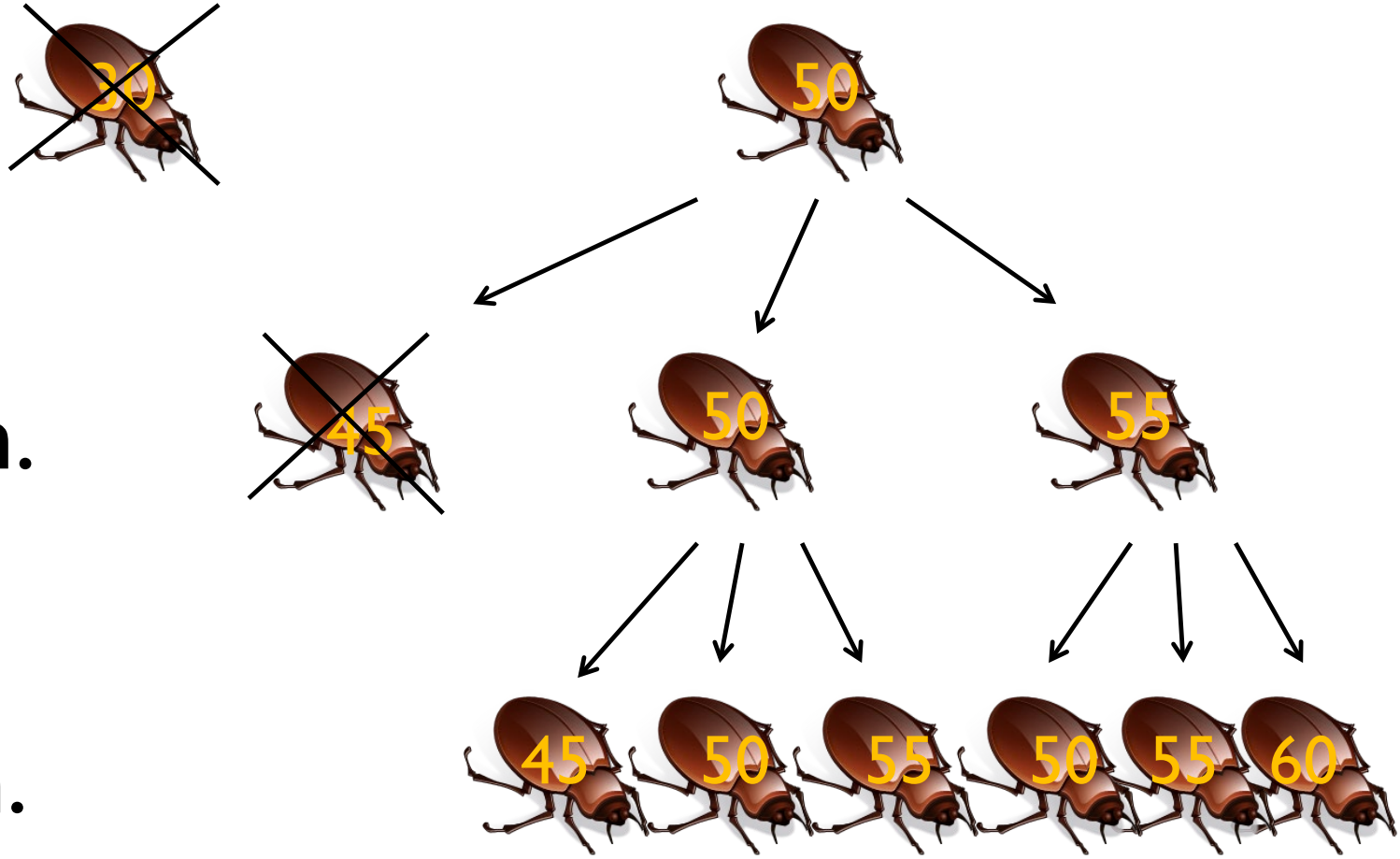


Your pests evolution should look like…..

1st Gen.

2nd Gen.

3rd Gen.



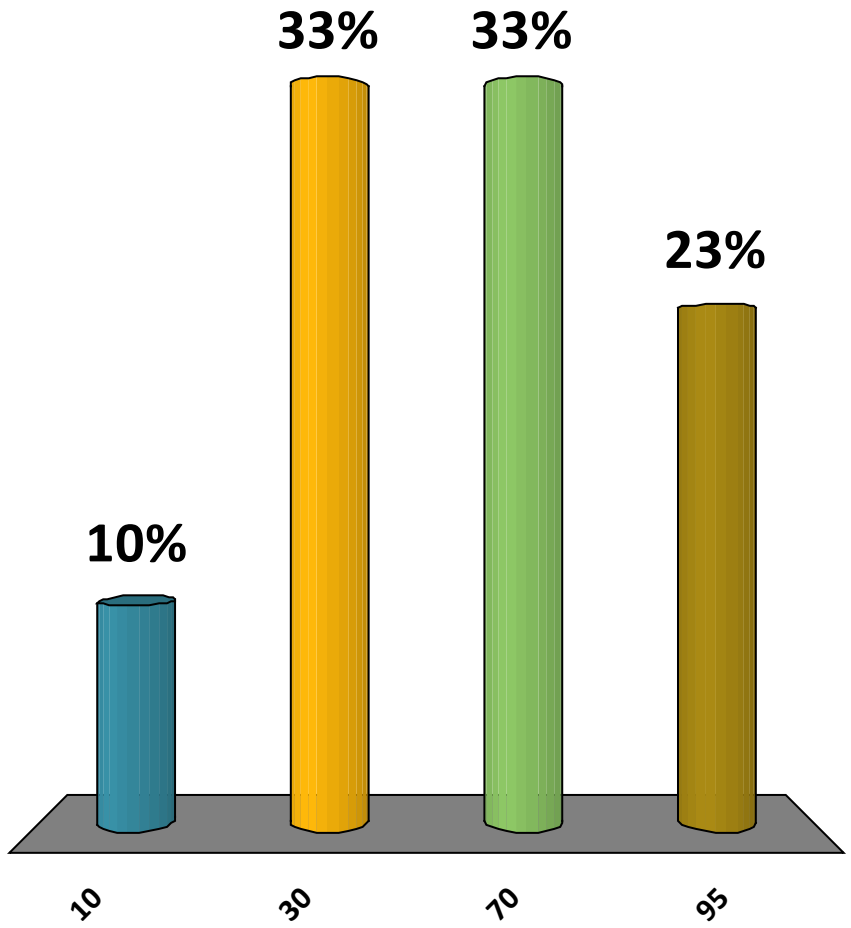

Working in
informal groups
What percentage of the
in the U.S. is supplied by
1. 3%
2. 10%
✓3. 25%
4. 50%
39%

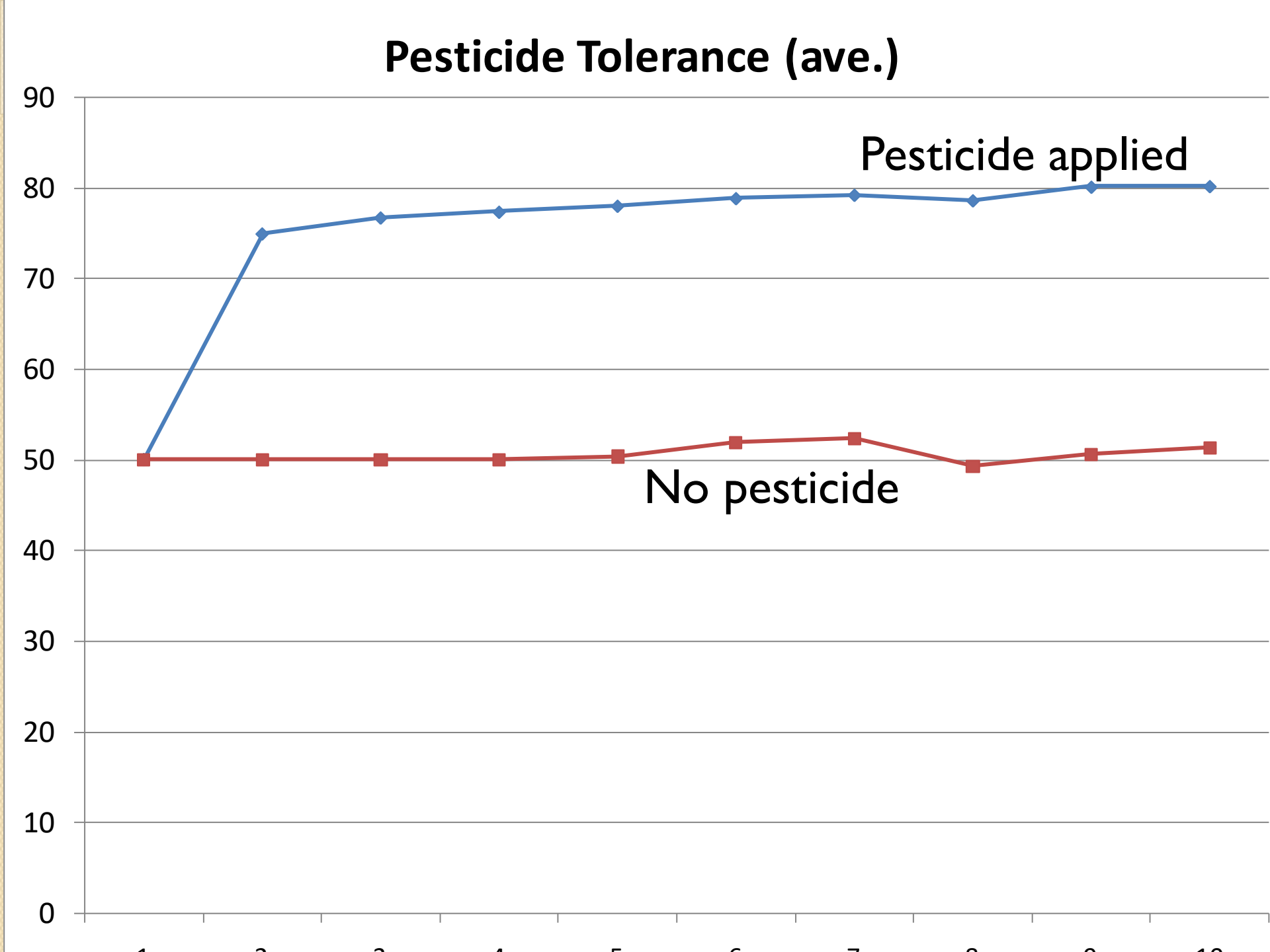
Part 2 – computer simulation

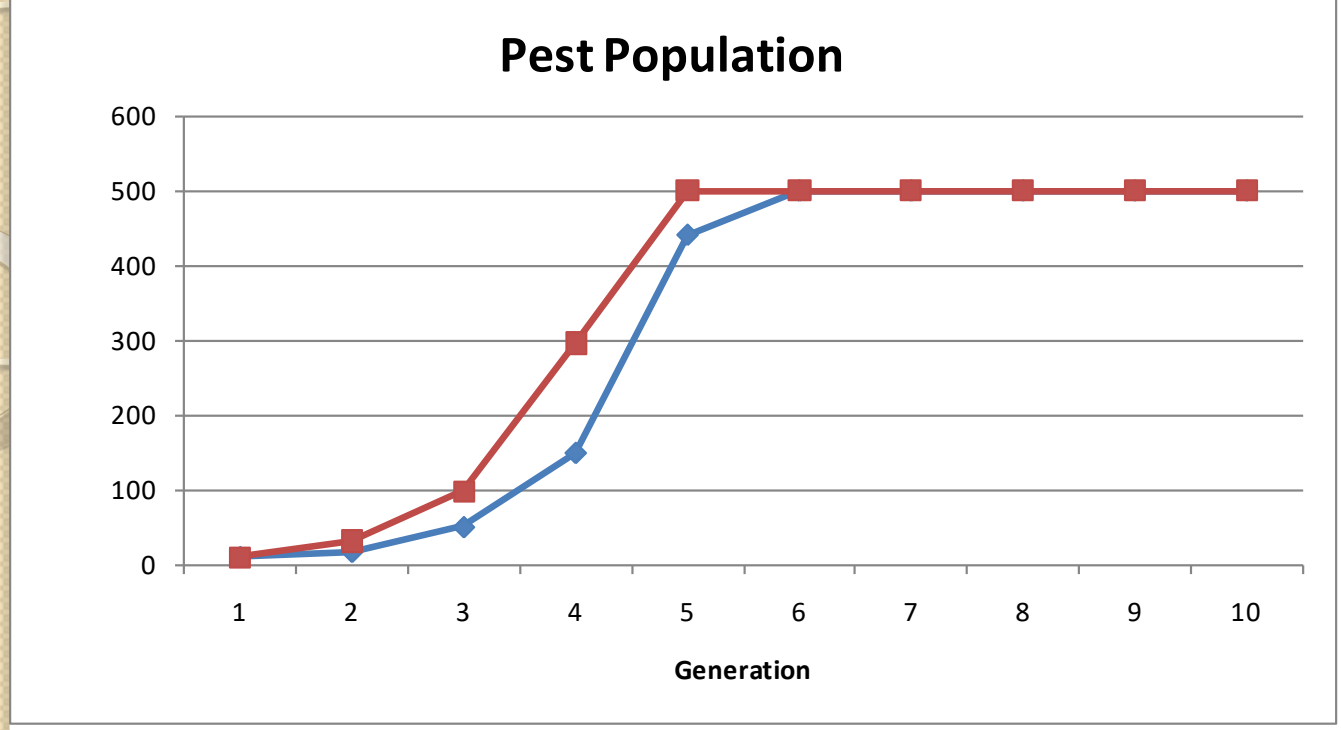
- Computer simulates paper exercise but faster and on a larger scale.
- Students can vote on simulation inputs using clickers.
- Simulation output helps students see patterns.

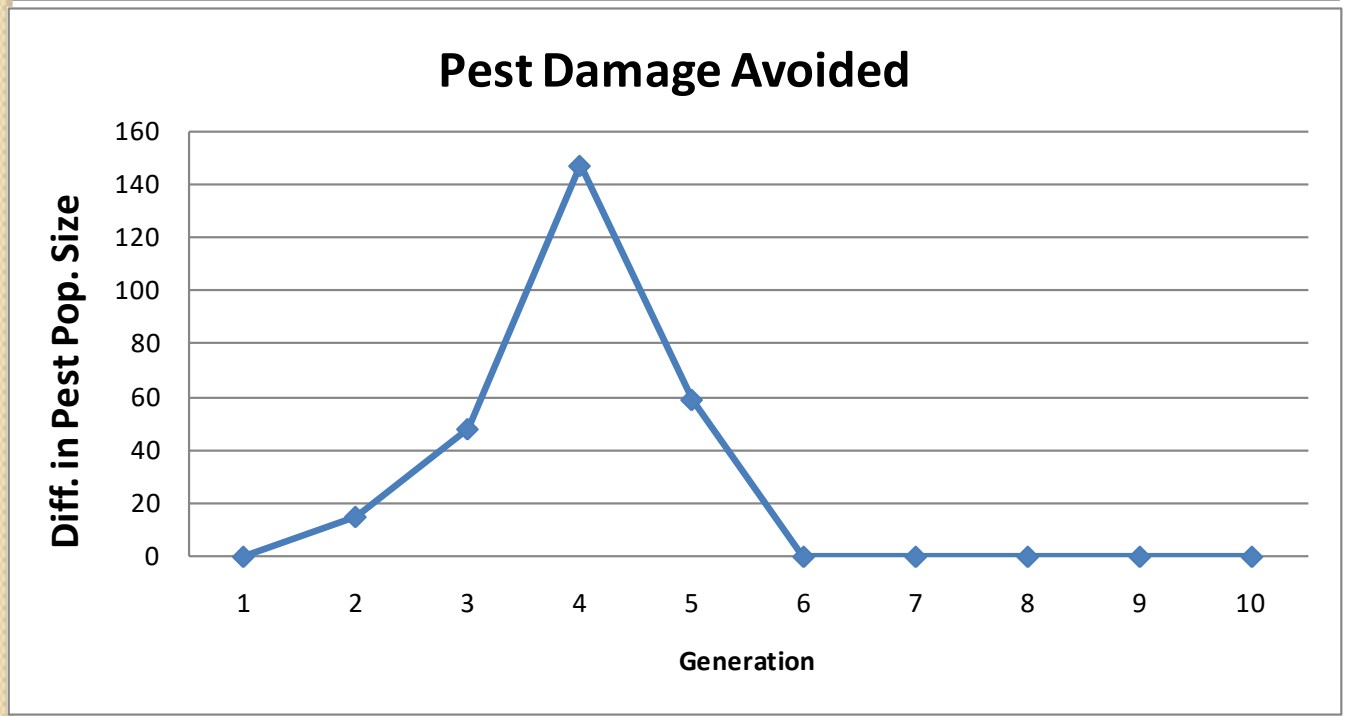
What new pesticide dose should we try?

1. 10
2. 30
3. 70
4. 95




Pesticide Tolerance (ave.)
90
80
70
60
50
40
30
20
10
0
Pesticide applied
No pesticide


Pest Population
600
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
10
Generation


Pest Damage Avoided
Diff. in Pest Pop. Size
160
140
120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
Generation

Module 11
Bioenergy

"Can bioenergy contribute to solving U.S. energy problems?"

"Can bioenergy contribute to solving global warming?"

"How can science help bioenergy become practical?"

Concepts to be "discovered."

- Energy flows from sunlight, to chemical energy in plants, to heat in an engine.
- The energy molecules in plants can be altered to better suit our fuel needs.
- Science can be used understand, evaluate, and improve bioenergy sources.

Make biodiesel from waste fryer oil in class

- What *is* waste fryer oil?


FEEDEY (SOUTHSIDE)

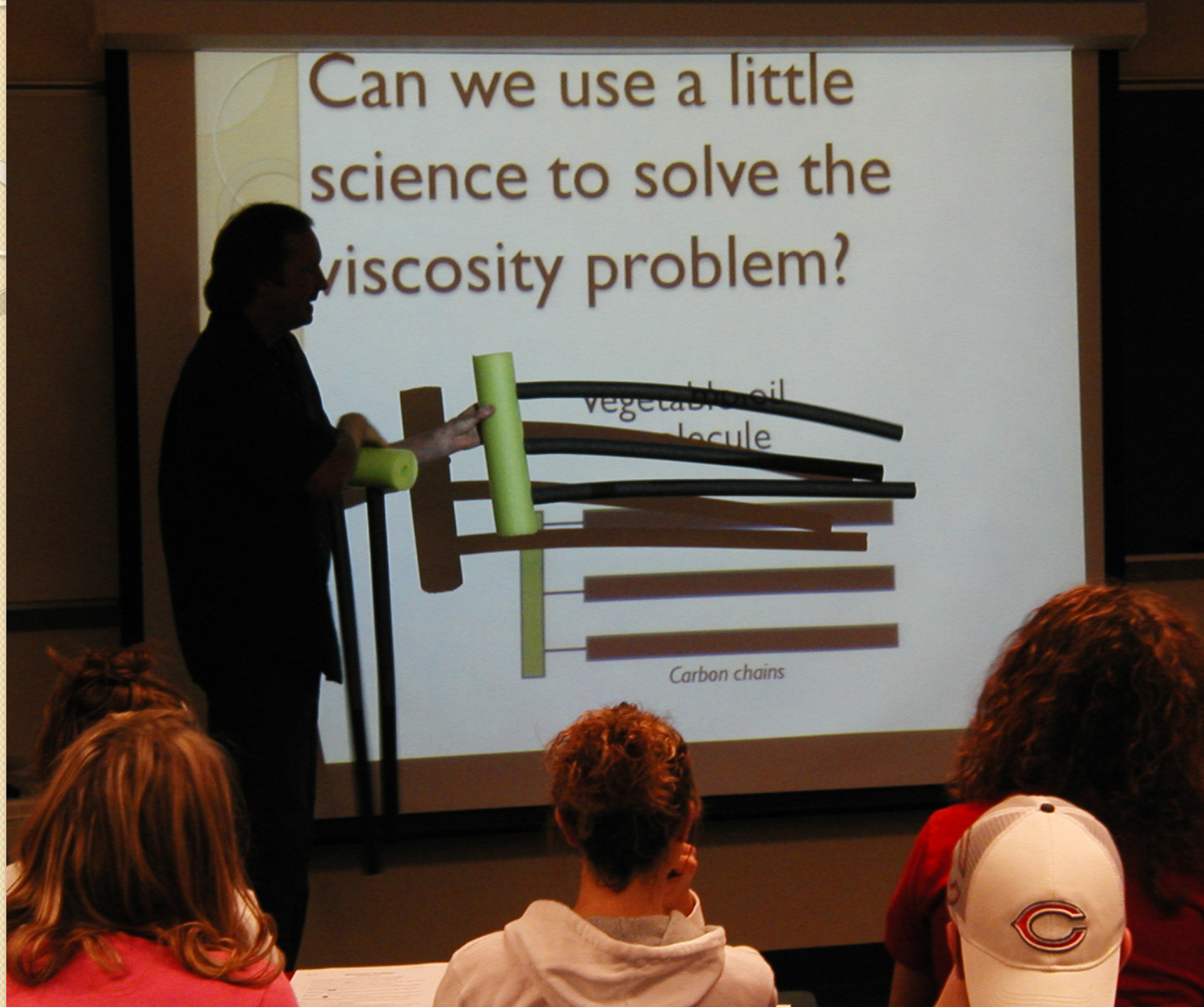
Will it burn?

- Will it work in a diesel engine?
- Too viscous!

How can we reduce it's viscosity but preserve it's fuel value?

- Can we alter the molecule?

Carbon chains


Can we use a little science to solve the viscosity problem?
Carbon chains


400
300
200
100

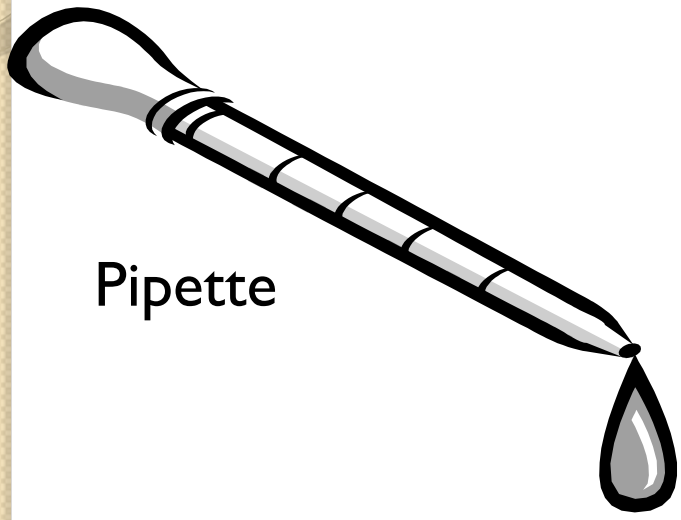
How can we tell if the product will have the right viscosity?

- Can we do an experiment?

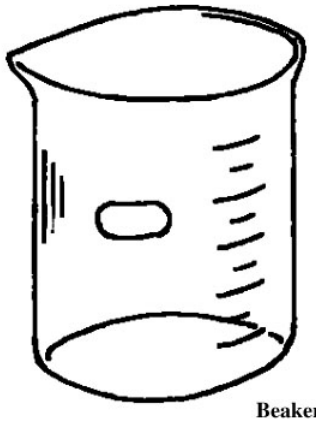
Biodiesel

Viscosity

given these objects…

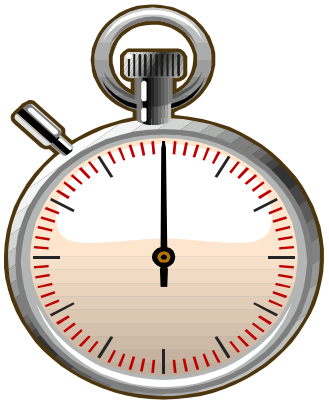


Pipette



Beaker

Biodiesel



Stop watch

How could we test the viscosity of biodiesel?

How would we know if it flows well enough?


ch 71
How could we test the visc

How can we tell if it burns well?

- Can we do an experiment?

Biodiesel

Results

- Greater student engagement and attention.
- Positive student feedback.
- Slightly better performance on exam and quiz questions, although not statistically significant.

Greater Engagement and Attention

- more active discussion among students, more relevant questions raised during class, and more additional questions after class.

- a dramatic decrease in distracted behavior and increase in attentive behavior.

Our teaching assistant Lucy Loftus doing class observations

Positive Student Feedback

Table 1. Student response to pesticide module

Student Responses	Questions (n = 242)	
	Better Understanding?	**More interesting?**
strongly agree	18%	12%
agree	65%	60%
neutral	11%	21%
disagree	5%	7%
strongly disagree	1%	0%

Positive Student Feedback

Table 2. Student response to bioenergy module

Student Responses	Questions (n = 153)	
	More interesting?	More interesting?
strongly agree	17%	26%
agree	59%	58%
neutral	17%	10%
disagree	4%	5%
strongly disagree	3%	1%

Impact on Learning Outcome

Table 3. Comparison of student learning outcomes on relevant quiz and exam questions

	Percentage correct		
	Traditional Class	Guided-Inquiry	p-value*
Quiz Performance	68.3%	70.7%	0.864
Exam Performance	74.0%	75.6%	0.591

* t-test

Conclusions

- The guided-inquiry learning modules appear to be more effective than traditional teaching methods in engaging students.
- Students also clearly enjoyed the activity more, and believed that it helped them understand the concepts better.
- More enjoyable for the instructors!

Conclusions

- More time consuming, both in terms of creating the module and implementing it.

- To use primarily when teaching complex or abstract concepts that students typically have trouble comprehending.