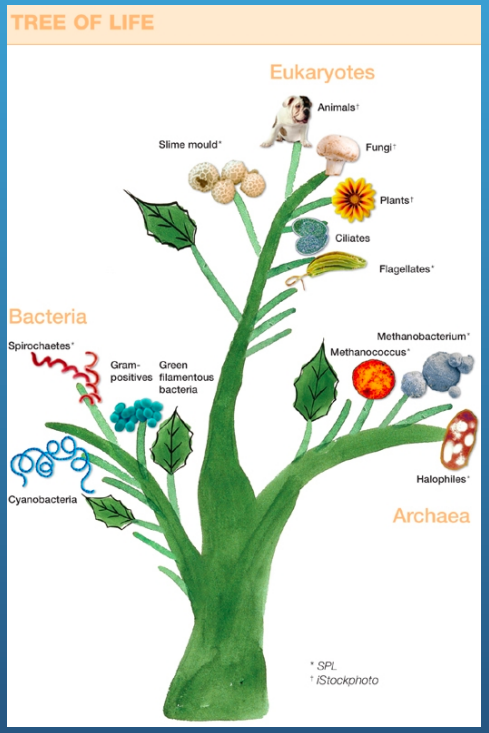
Unifying life: Placing urban tree diversity into an evolutionary context

Yael Wyner, City College of New York/CUNY;
Jennifer Doherty, Michigan State University

NSF DRK12# 12211888

Goals

- Immerse urban students in local biodiversity
- Place life's diversity into an evolutionary context

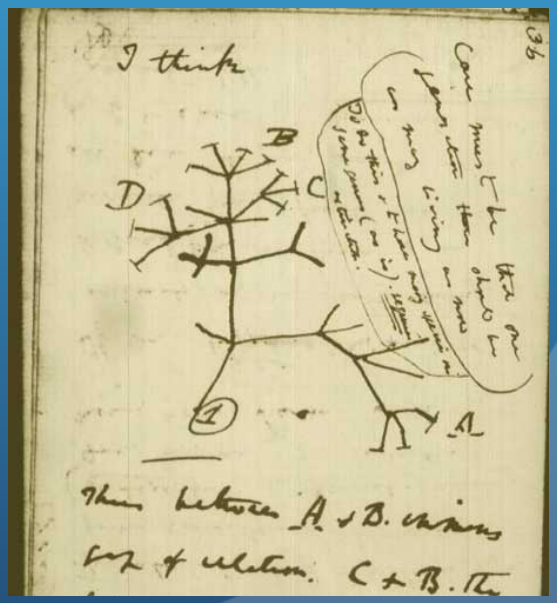


Immerse urban students in local biodiversity

- Eighty percent of Americans live in cities or suburbs disconnected from the outdoors (Miller 2005)
- Unknowingly surrounded by many forms of life
  - Street trees provide an opportunity to engage students in biodiversity (leaf, fruit, flower structure)
- Counteract plant blindness

Place life's diversity into an evolutionary context

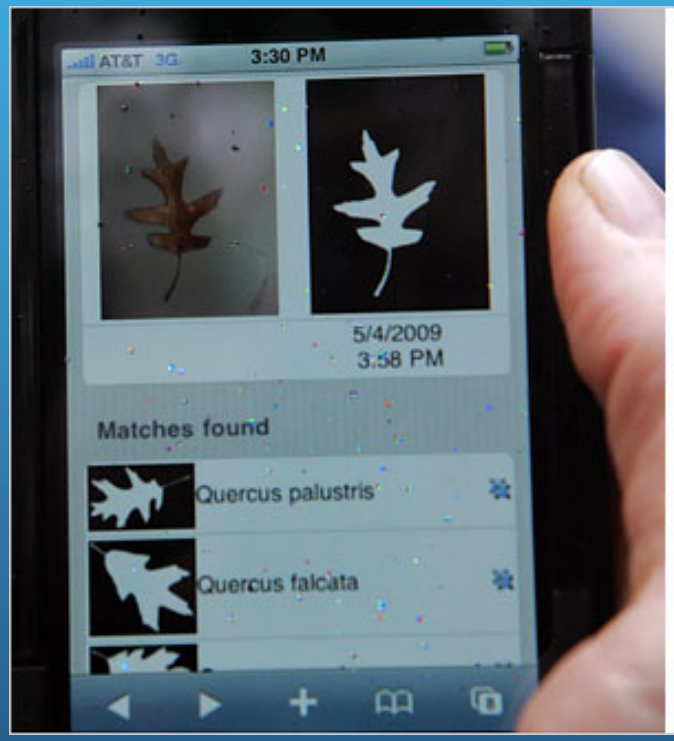
- Shared fruit, leaf, and flower structure is evidence of common descent.
- Two major ideas proposed by Darwin:
  - Unity of Life (pattern)
  - Natural Selection (process)
- Schools almost exclusively focus on natural selection (Catley 2006)

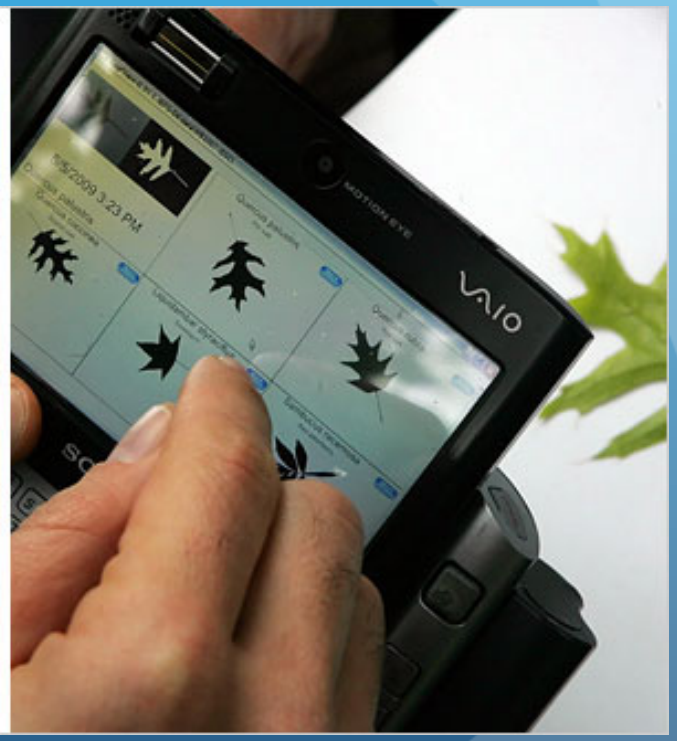


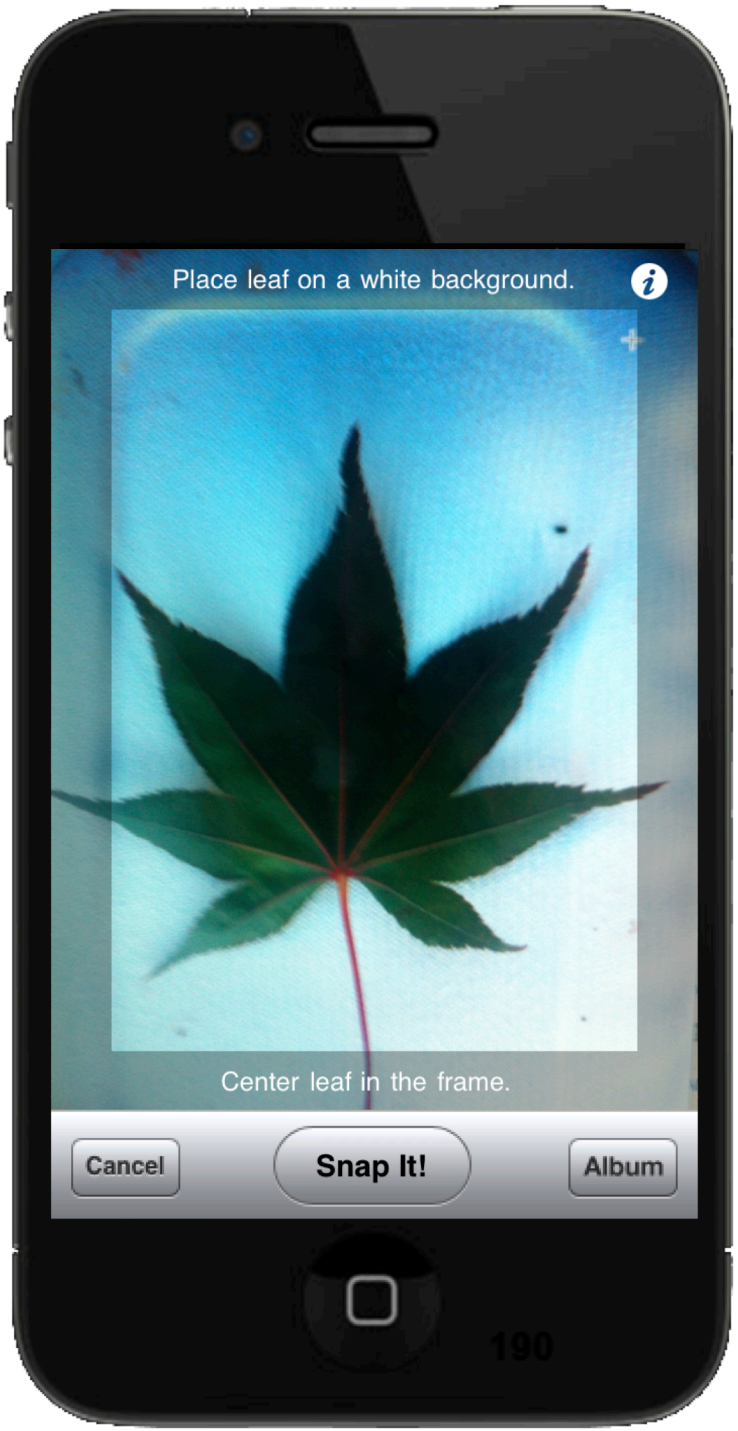
Place life's diversity into an evolutionary context

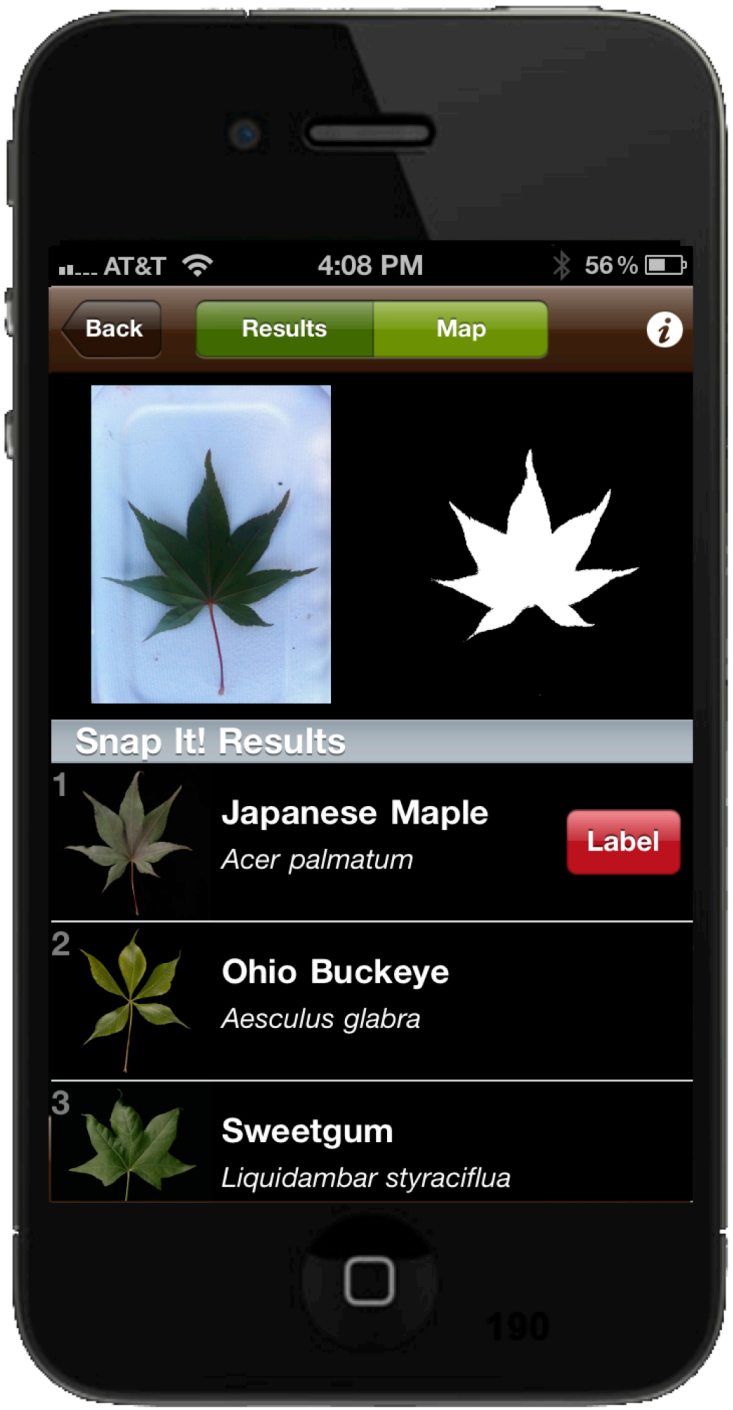
- Historical significance of each individual species – a species is a record of its past, a culmination of its evolutionary history (Leopold 1949; Janzen 2004)
- Current issues in biology (Catley 2006)
  - Conservation
  - Model organisms for the study of disease

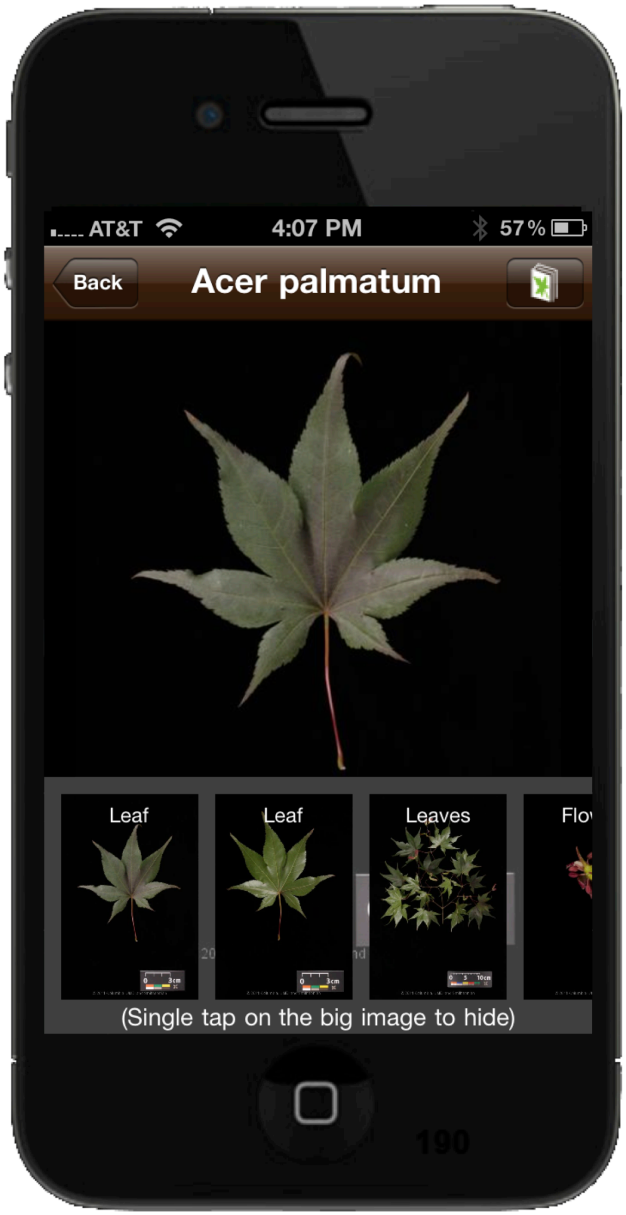
Leafsnap – tree identification app optimized for New York City






Place leaf on a white background.
Center leaf in the frame.
Cancel
Snap It!
Album


AT&T
4:08 PM
56%
Back
Results
Map
Snap It! Results
1
Japanese Maple
Acer palmatum
Label
2
Ohio Buckeye
Aesculus glabra
3
Sweetgum
Liquidambar styraciflua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57 %
Back
Acer palmatum
Leaf
Leaf
Leaves
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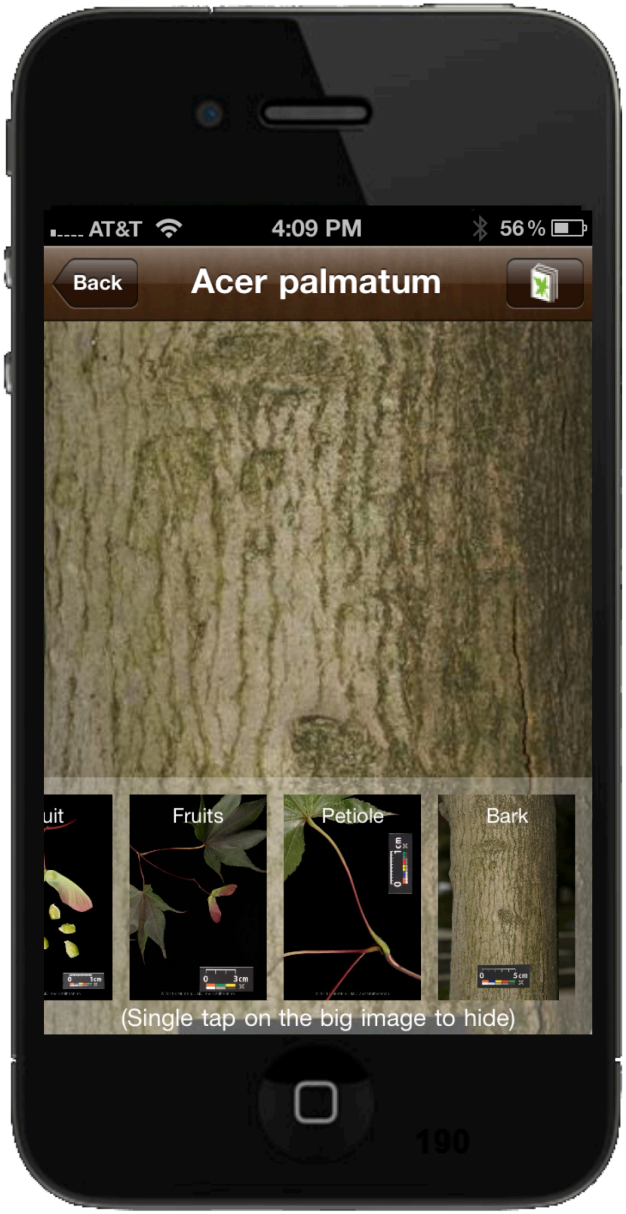
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Acer palmatum
Fruits
Petiole
Bark
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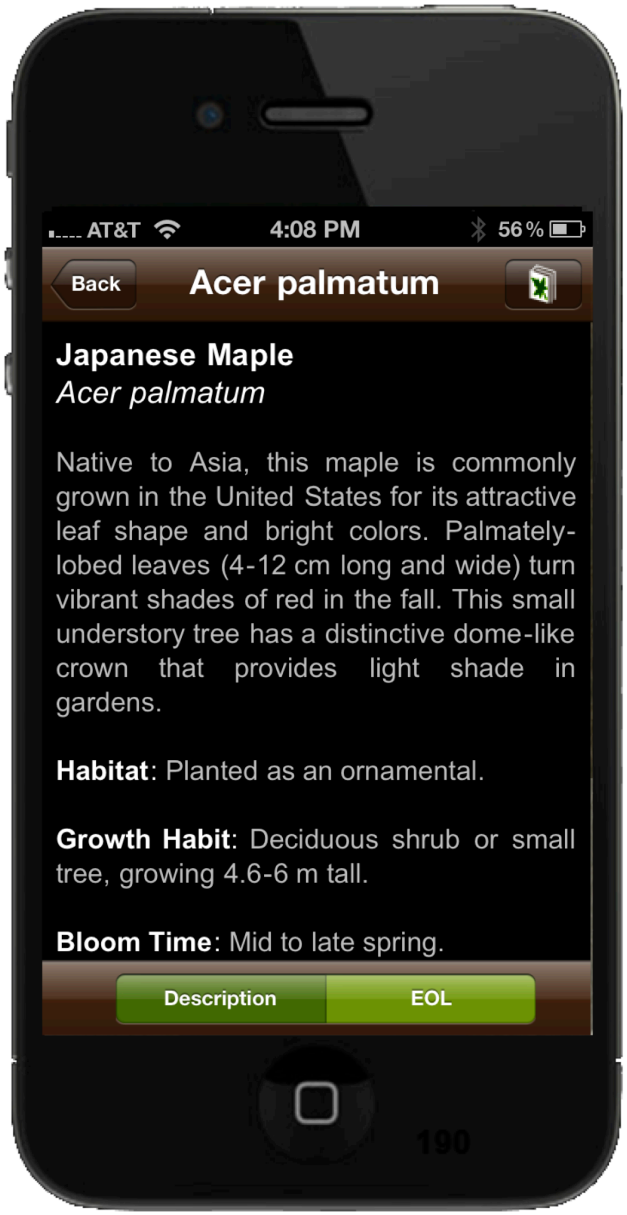
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Back
Acer palmatum
Japanese Maple
Acer palmatum
Native to Asia, this maple is commonly grown in the United States for its attractive leaf shape and bright colors. Palmately-lobed leaves (4-12 cm long and wide) turn vibrant shades of red in the fall. This small understory tree has a distinctive dome-like crown that provides light shade in gardens.
Habitat: Planted as an ornamental.
Growth Habit: Deciduous shrub or small tree, growing 4.6-6 m tall.
Bloom Time: Mid to late spring.
Description
EOL

Research Goal

How do students understand street tree diversity before and after using the Unifying Life-Leafsnap curriculum?

How do students understand street tree diversity before and after using the Unifying Life-Leafsnap curriculum?

- What **characteristics** students notice to **identify** street trees?
- What **characteristics** students use to **group** trees by relatedness?
- What it means to be **related**?

Develop curricular resources for middle school students

- Fall Curriculum: Focus on leaves, fruits, evolutionary constraint, and common ancestry (Note: Today's discussion is only based on the implementation of the fall curriculum)
- Spring Curriculum: Focus on flowers, tree life cycle, evolutionary constraint & common ancestry

Develop curricular resources for middle school students

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Testing curricular resources in the classrooms of 12 NYC middle school teachers

- 1 middle school in Manhattan (6th grade)
- 1 middle school in Brooklyn (8th grade)
- 2 middle schools in Queens (6th & 7th grade)
- 2 middle schools in the South Bronx (6th, 7th, & 8th grades)
- Attend a week long professional development over the summer with a botanist; reviewed curriculum; completed curricular activities; feedback on curricular resources etc. (continue to do so – complete online questionnaires about each lesson; focus group)

Analysis of 19 pre/post (fall only) interviews and written assessments (N=322)

- What **characteristics** students notice to **identify** street trees?
- What **characteristics** students use to **group** trees by relatedness?
- What it means to be **related**?

What **characteristics** students notice to **identify** street trees?

- The characteristics they would use to identify an unknown tree
- Identify trees from pictures

Four levels of understanding about characteristics use for identification

Level 1:

Where it grows *and stuff usually* ***determines*** *what* ***it's called***

Use uninformative characteristics like location, tree height and size, reference to animals living there

Four levels of understanding about characteristics use for identification

Level 2:

Leaves *. . . 'Cause each tree . . . their leaves have a certain* ***shape****.*

Students generally use leaves

Four levels of understanding about characteristics use for identification

Level 3:

*I would look at its leaf patterns, 'cause most of them either have **opposite leaf patterns** or they have **alternate leaf patterns** . . . and I would look at the **leaf shape**, if it's **toothed**, if it's **lobed** . . .*

Students use specific leaf characteristics like leaf edge, shape & arrangement or specific fruits

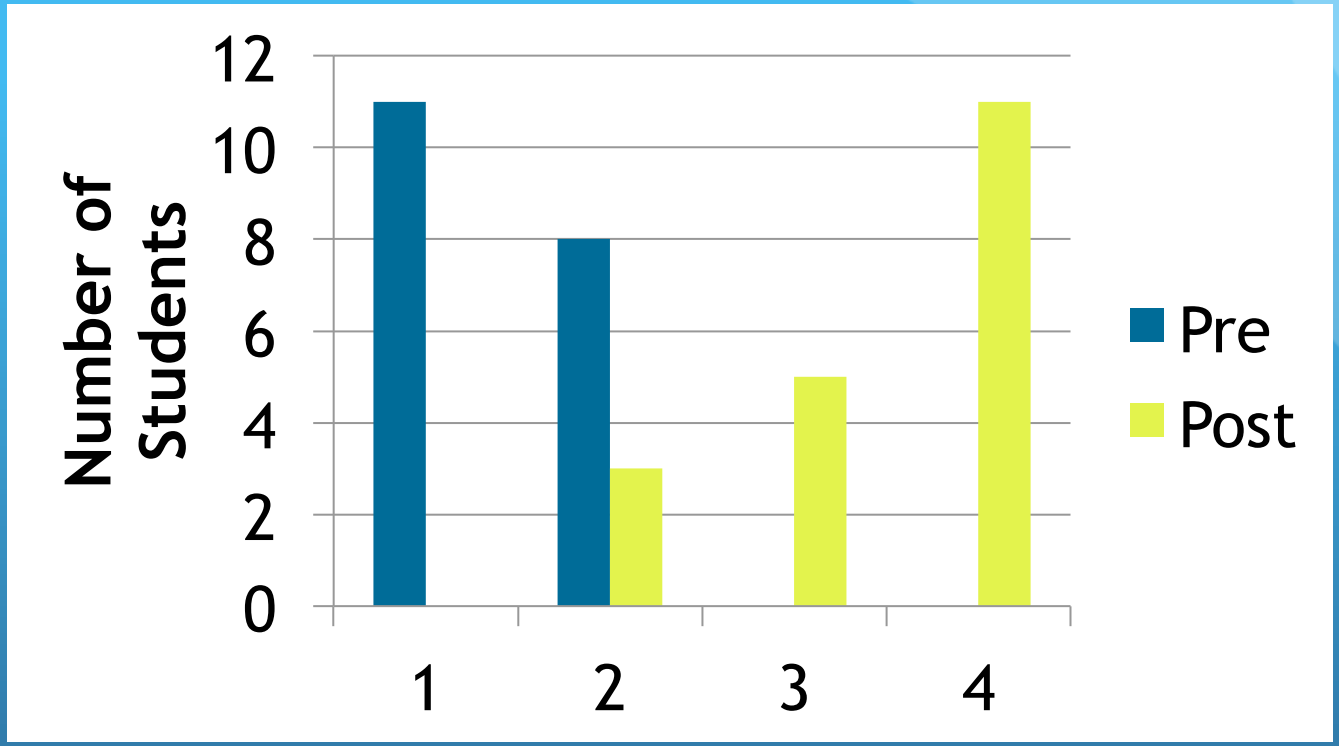
Four levels of understanding about characteristics use for identification

Level 4:

*You would probably want to notice the **fruit**, if there is any, and the **leaf**. Well, the fruit, just what **type** of it. . . You would want to look at the **edges** of the leaf, because that can help **differentiate between two close competitors**, and you would also want to look at the **shape**, like if it's **simple or lobed***

Students use specific leaf characteristics like leaf edge, shape & arrangement & fruit

Characteristics Students Notice to Identify Trees



- Level 1: Use uninformative characteristics
- Level 2: Generally use leaves
- Level 3: Use specific leaf characteristics or specific fruits
- Level 4: Use specific leaf characteristics and fruits

Red Maple ID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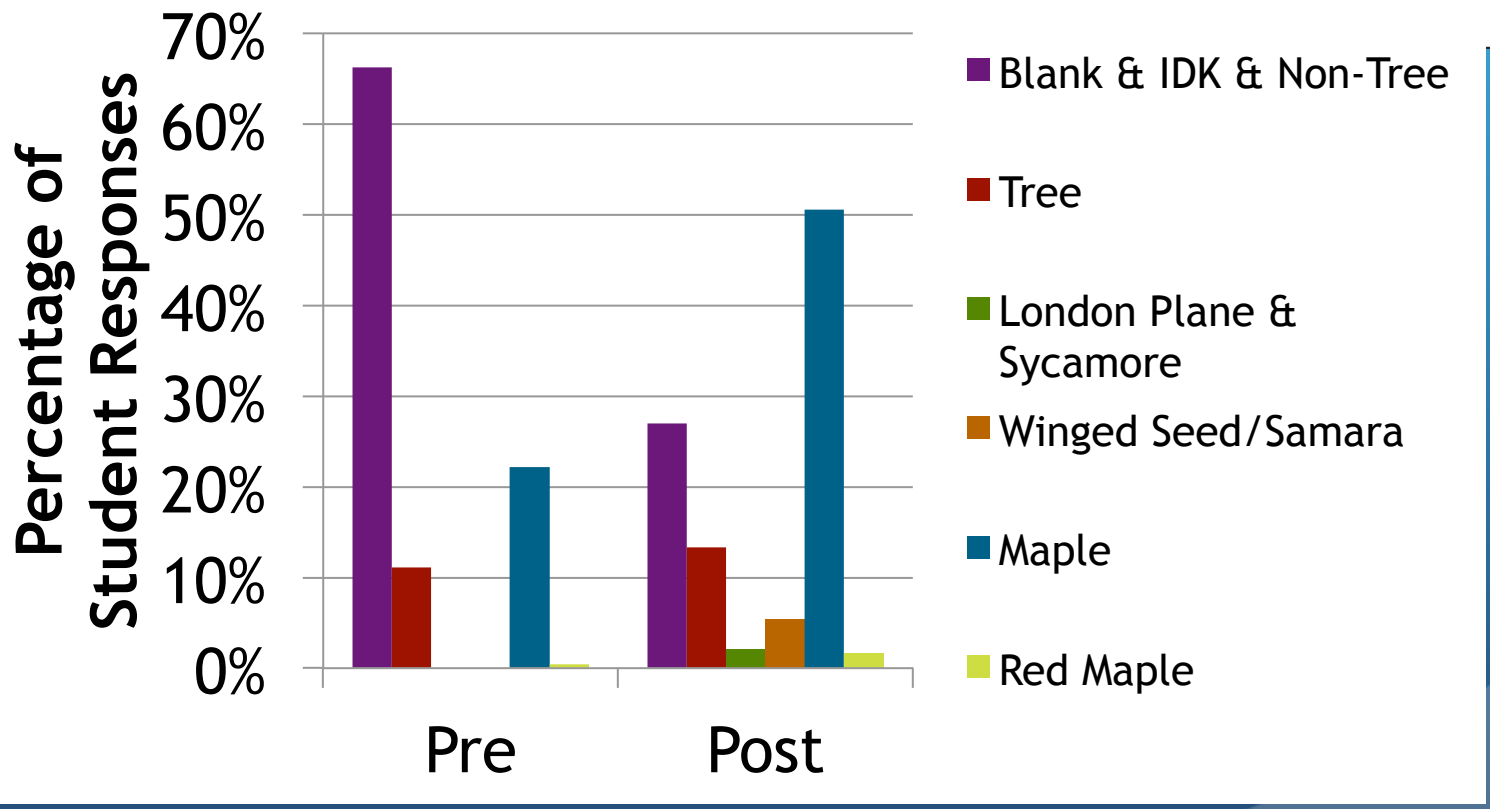
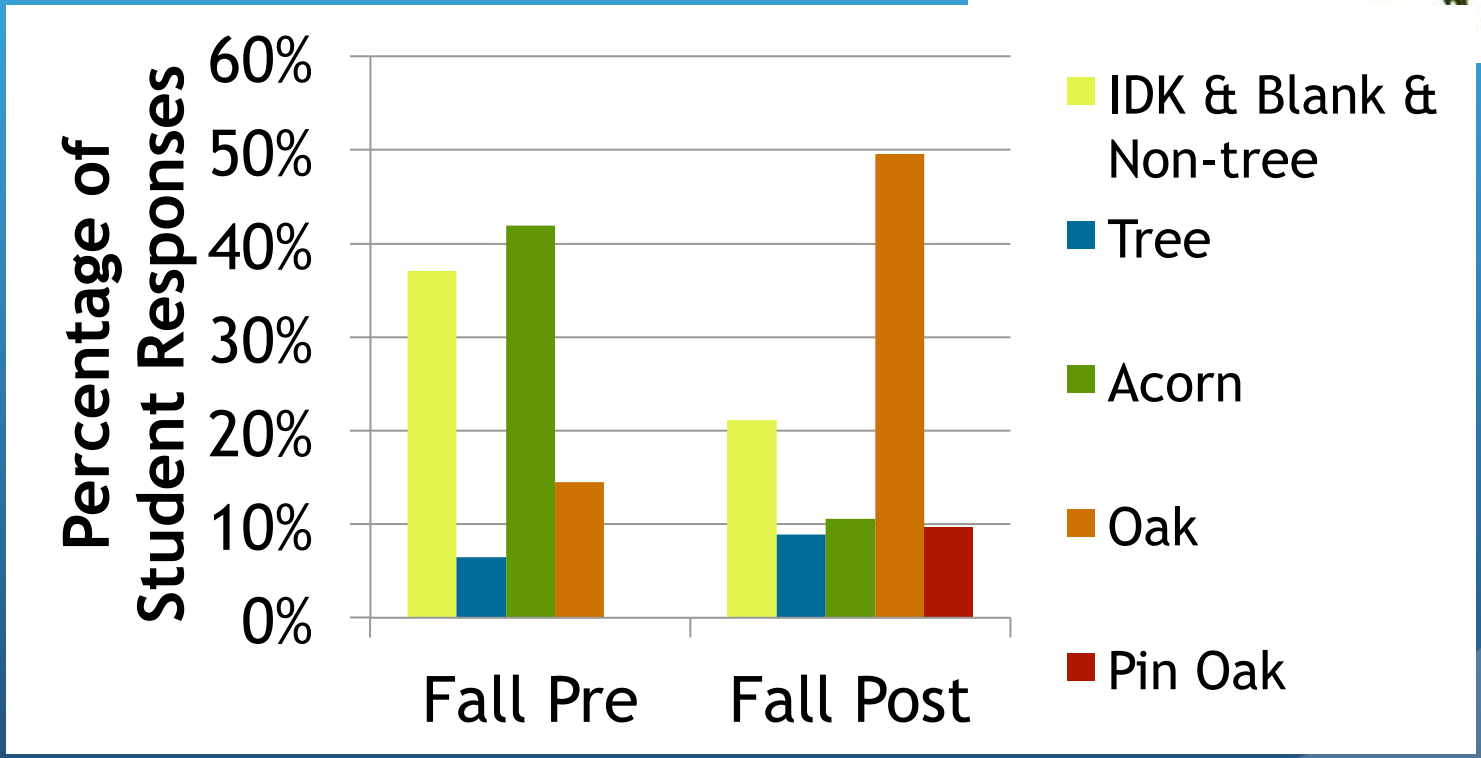

Percentage of Student Responses
70%
60%
50%
40%
30%
20%
10%
0%
Pre
Post
Blank & IDK & Non-Tree
Tree
London Plane & Sycamore
Winged Seed/Samara
Maple
Red Maple

Pin Oak ID


Percentage of Student Responses
60%
50%
40%
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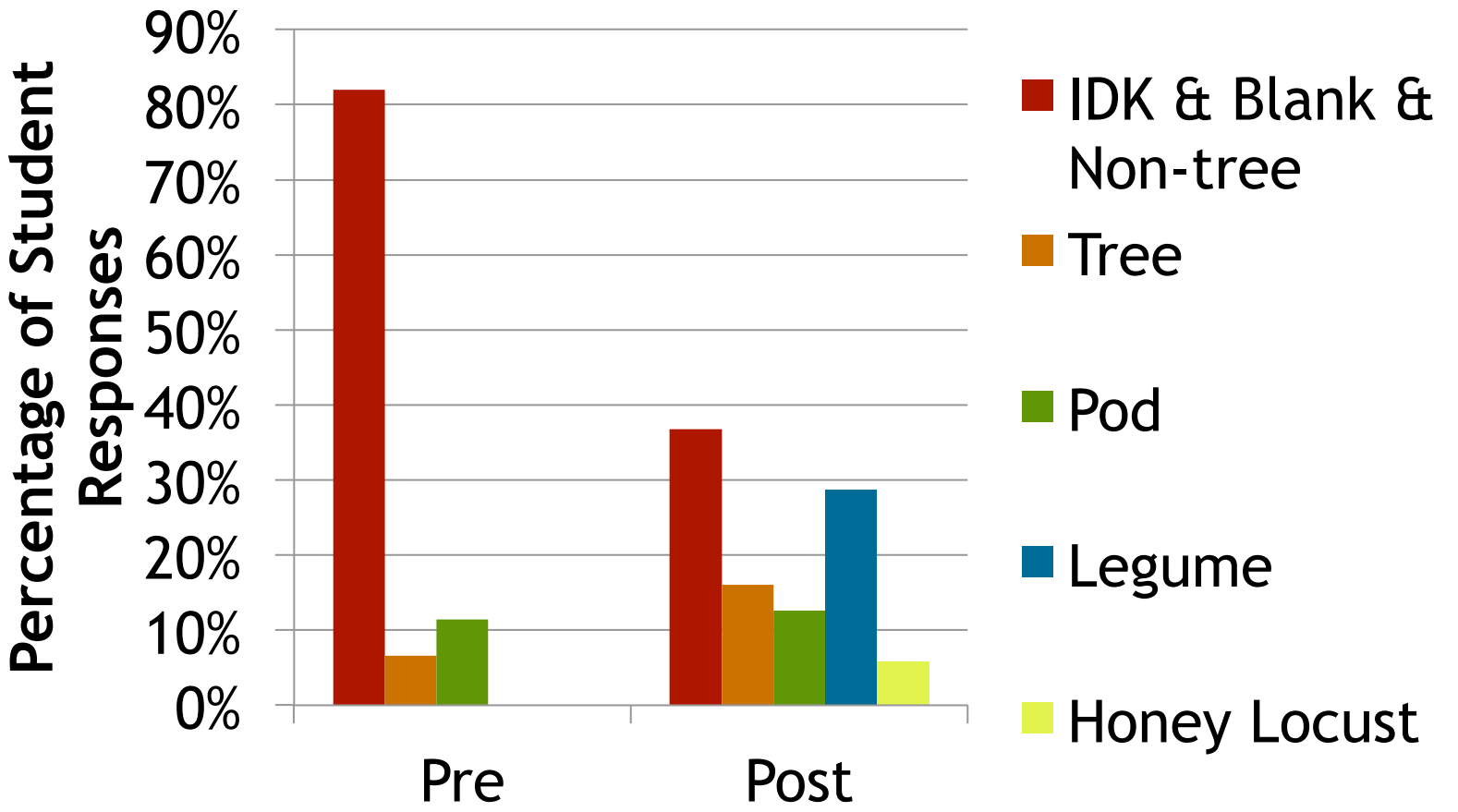
10%
0%
Fall Pre
Fall Post
IDK & Blank & Non-tree
Tree
Acorn
Oak
Pin Oak

ID Honey Locust



PRE

Acorn
Apple
Apple; Crab
Berry
Birch
Blank
Cherry
Cherry, Blossom
Chestnut
Cypress
Elm
Evergreen
Ficus
Flowers
Furnace
Ginkgo
Hardwood
Linden
Linden, European
London Plane
London
Maple
Maple, sugar
Oak
Olive
Oval Leaves; Short
Pine
Plum
Spruce
Sycamore

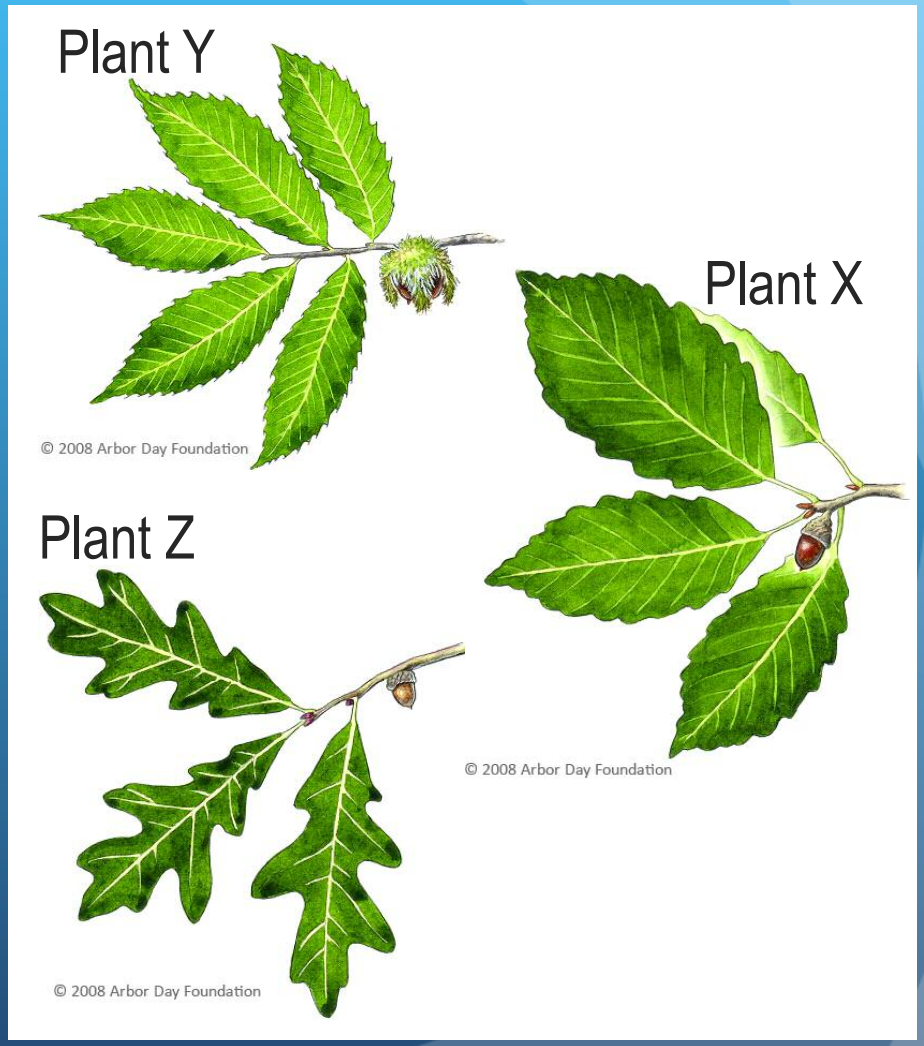
What are the names of the trees that live on the block in front of your school?

POST

Apple, Paradise
Ash
Birch
Birch, White
Blank
Buckeye
Buckeye, silver
Catalpa
Catalpa, Northern
Cherry
Cherry, Blossom
Chestnut, American
Cone
Dogwood
Elm, English
Evergreen
Ginkgo
Hawthorn
Hawthorn, Green
Holly
Honey Kissed
Hornbeam, European
Katsura
Legume
Lilac
Linden
Linden, American
Linden, European
Linden, Little Leaf
Linden, Silver
Linden, Tilia
Locust, Black
Locust, Honey
London Plane;
Magnolia, Star
Maple
Maple nut
Maple, Chinese
Maple, English
Maple, Japanese
Maple, London
Maple, Norway
Maple, Pine
Maple, Red
Maple, silver
Maple, Sugar
Maple;
Mulberry
Mulberry, Paper
Oak
Oak, Black
Oak, Maple
Oak, Northern
Oak, Northwood
Oak, Pin
Oak, Pine
Oak, Red
Oak, Sawtooth
Oak, Scarlet
Oak, Sugar
Oak, Willow
Orchid, purple
Orchids
Pear, Callery
Pear, Melody
Pear, Muddy
Pear, Polary
Pin
Pine
Plane, London
Plum
Pomegrenate
Redbud
Samara
Silver
Spruce
Sycamore, American
Tilia tomentos
Umbrella Tree
Willow

What **characteristics** students use to **group** trees by relatedness?

- Is plant X a descendant of plant Y or plant Z? How do you know?



Three levels of understanding about characteristics to use for grouping

Level 1:

*I would say they're **not related** because of the **leaf structure***

Student prioritizes leaves (edge, shape, arrangement), but not fruit

Three levels of understanding about characteristics to use for grouping

Level 2:

*I would say they're probably **in between closely related** and **not related** because their **leaves are extremely different**, like really, really different, but they do have a **similar-ish fruit** and leaf structure, where it's opposite/alternate*

Student sometimes prioritizes fruit, but not always

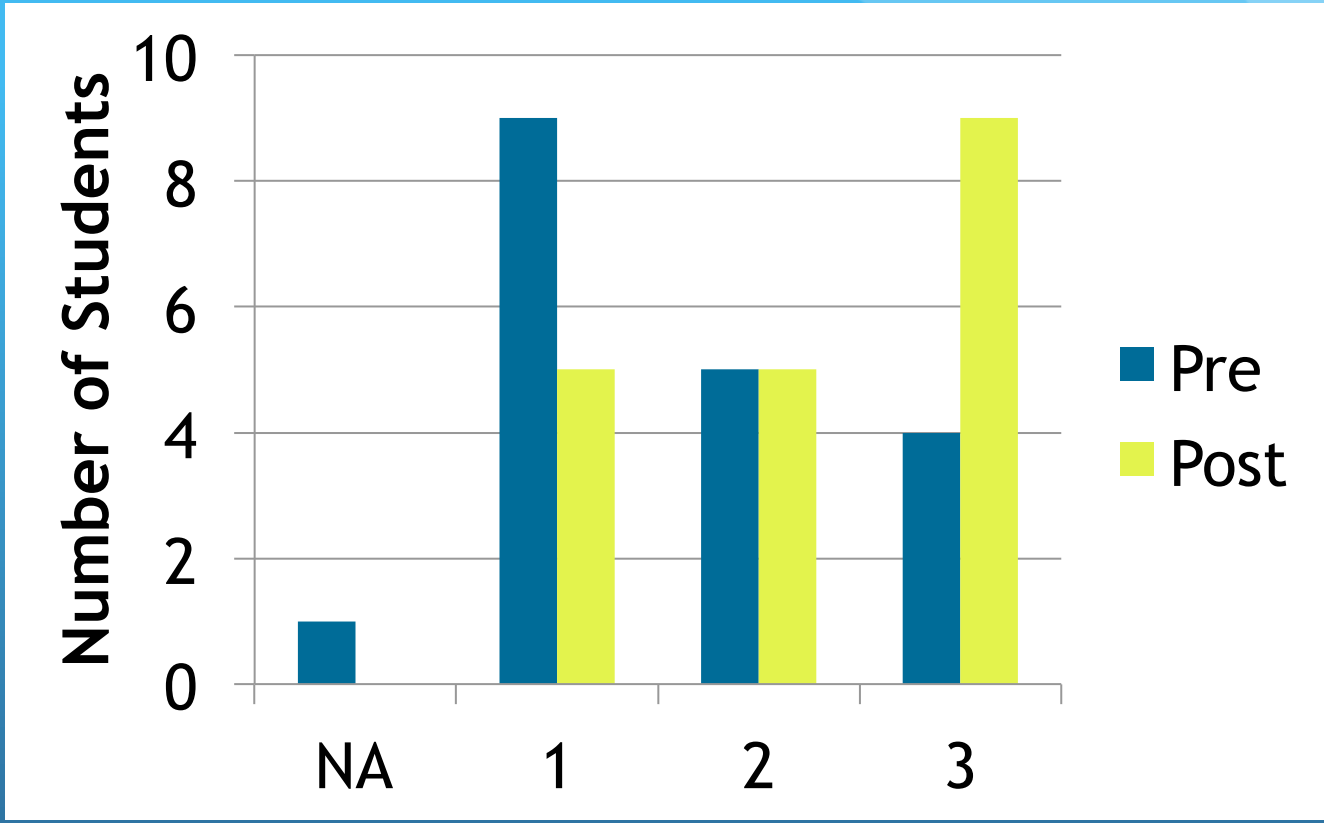
Three levels of understanding about characteristics to use for grouping

Level 3:

*I wrote closely related once again, because it was only the leaf shape that was different, but they had the **same fruit** and it had the same leaf arrangement.*

Student always prioritizes fruit

Characteristics students use for grouping pre/post



Level 1: Student prioritizes leaves (edge, shape, arrangement), but not fruit

Level 2: Student sometimes prioritizes fruit - not always

Level 3: Student always prioritizes fruit

What it means to be **related**?

- Questions that directly asked and that were designed for students to address relatedness

Four levels of understanding about what it means to be related

Level 1:

*It means that **they are similar** to each other*

Organisms are similar

Four levels of understanding about what it means to be related

Level 2:

*It means you have some of the **DNA** to produce the same thing. Like when **parents pass down to their children**, you have **variations**, but we **still have something in common** with them.*

Organisms are similar due to inheritance

Four levels of understanding about what it means to be related

Level 3:

I guess they could be descendants of each other and maybe ancestors, and the trees changed over time.

Some misconceptions too.

Organisms are similar because they share a common ancestor

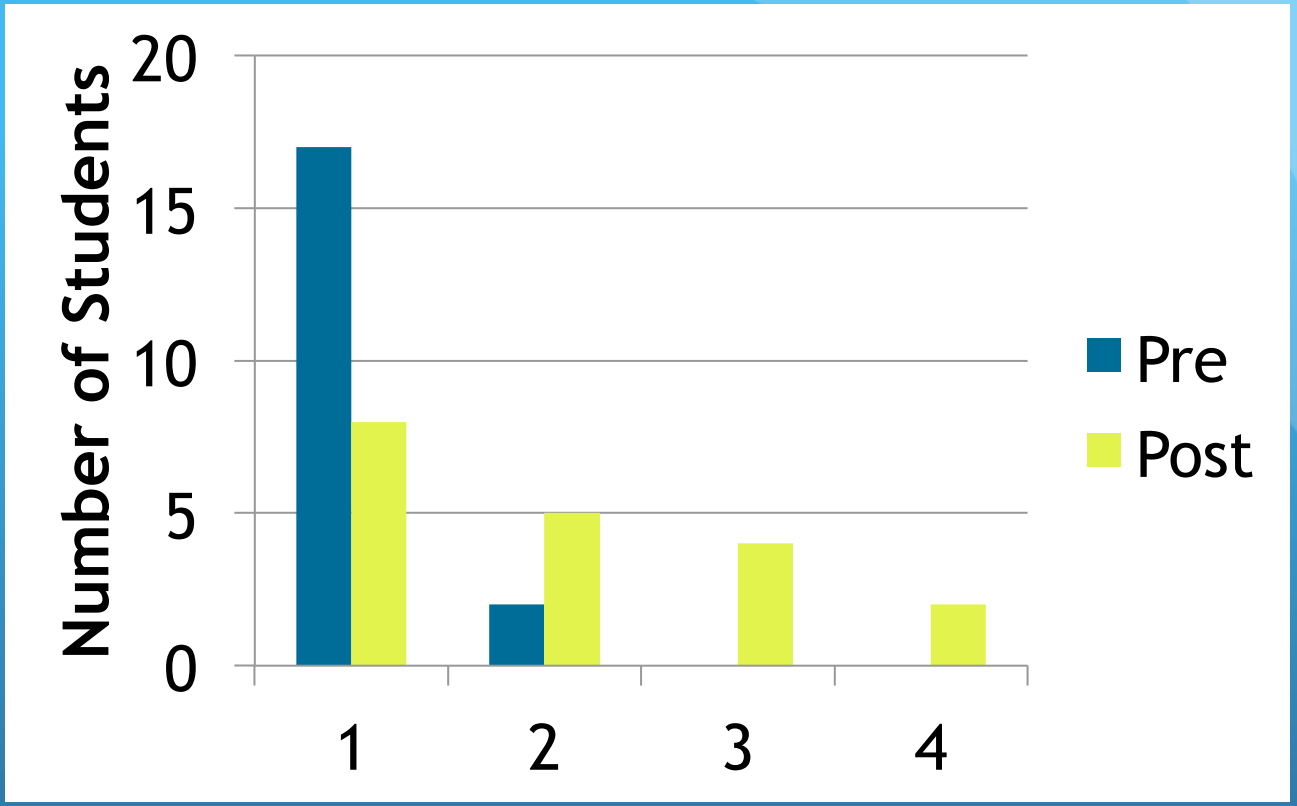
Four levels of understanding about what it means to be related

Level 4:

*I think that closely related is that and maybe they might **come by the same ancestor tree**. Like a tree that started it all, 'cause trees reproduce, so maybe when **it had other trees**, when it reproduced, they started to evolve and **maybe change a few characteristics** of themselves and stuff. So, maybe they might **come from one willow tree**, like let's say **all willow trees come from one primary willow tree and characteristics changed and leaves were altered and stuff**. Maybe – trees have been with us since the days of the dinosaurs, so it would probably **be millions, billions of years to evolve**.*

Organisms are similar because they share a common ancestor from a long time ago

Understanding about relatedness pre/post



Level 1: Organisms are similar
Level 2: Organisms are similar due to inheritance
Level 3: Organisms are similar because they share a common ancestor
Level 4: Organisms are similar because they share a common ancestor from a long time ago

What we are learning

Characteristics Notice to Identify

- Prior to instruction, generally students do not have the tools to closely notice the trees that surround them.
- Providing students with these tools helps them notice and identify the trees that surround them.

Characteristics to Group

- Prior to instruction, many students do not have the tools to group the trees that surround them.
- Providing students with these tools helps them group these trees.

What we are learning

What it means to be related

- Prior to instruction, students do not consider that species relatedness is connected to evolution
- With instruction, students can make those connections to evolution and common ancestry (more instruction in the spring)

Thank You

- Curriculum: Janice Koch, Hofstra University; Sarah Seiter, Renee Thorne & Jessica McVeigh, CCNY; Professional Development: Botanist Margaret Conover, Stony Brook; Jamie Boyer, New York Botanical Garden; School Visits: Greg Borman, CCNY
- 15 NYC public school teachers and their students
- Advisory Panel: Andy Anderson,MSU; Alan Berkowitz, Cary Institute; Kefyn Catley, Western Carolina University; Chelsea Specht (UC Berkeley)
- *Leafsnap* Developers: David Jacobs, University of Maryland; Peter Belhumeur, Columbia University; John Kress, Smithsonian Institute
- Unifying Life: Placing Urban Tree Diversity in an Evolutionary Context (DRK12-#1221188) All views are those of the authors and not of the NSF.