Are Our Students Taxonomically Challenged or Not?

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Education

Abstract

A class exercise to introduce plant taxonomy to non-science majors was conducted as part of the botany segue (introduction to botanical sciences) of our introductory ethnobotany course at the University of Hawai`i in fall 2007. Students were given the opportunity to name and develop their own classification schemes for forty plant materials. This paper discusses the results of the class exercise. Binomials were used more often than monomials for plant names and the pattern was reversed for category names. Students used many adjectives and terms related to plant parts to name plants and categories. Of all the adjectives used, color and texture were used most often by students to name plants and categories respectively. In general, students were well aware of the different functional roles of plant and category names and illustrated this frequently by using binomials consisting of noun-adjective combinations to name plants and monomial nouns to name categories.

Introduction

Taxonomy is the study of the general principles of scientific classification (Merriam-Webster 2008). Wikipedia (2008) further describes taxonomy as the practice and science of classification. Both definitions imply the use of scientific method in the classification process but humans have been classifying objects and events around them long before the modern science of classification was propounded (Sokal 1974) with the binomial system of nomenclature dating from Linnaeus in 1753. The second International Botanical Congress was held in Vienna, Austria in 1906, and accepted the first international rules governing the names of plants (McNeill *et al*. 2006). This is clearly a milestone in plant taxonomy but it must also not be forgotten that before this major event, humans had already been consistently and systematically classifying the biological universe around them (Berlin 1973). This is not surprising as one important skill that has helped humans survive thus far on Earth is their uncanny ability to discern similarities and discontinuities in the natural world (Raven *et al*. 1971). Humans have used this ability to partition the natural world into related categories that serve to guide their inferences about the world (Lopez *et al*. 1997). While we may ponder if this particular endowment is an evolved instinct or a learned process, the general consensus is that categorization is a fundamental human cognition process that constantly takes place in the human mind (Coley *et al*. 1997). It is through this cognition process that humans construct categories that, according to one school of thought, reflect the universal structure of the natural world (Berlin 1992), and another school the conceptual view of the person doing the categorization (Atran 1990). A middle ground then is the view that categories are products of the interplay between the human mind and the natural environment (Lopez *et al*. 1997, Medin *et al*. 1997). While categorization may be a skill that we practice every day (Ashby & O'Brien 2005), the same cannot be said of the naming of things unless we include the occasional naming of filenames on our computers. However, this does not imply that assigning

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names to things is of lesser importance because one precondition of classification is the naming of things themselves (Wignell *et al*. 1993). In the biological sciences, organisms are named using the 250-year old Linnaean system of binomial nomenclature which itself is not without its problems. Nevertheless, the Linnaean system provides a relatively convenient way for scientists to talk about most living organisms in the world without worrying if they are referring to the same organism. Thus, an important function of any nomenclature system is to provide a universal way for users to communicate effectively about things. Likewise, people of the same cultural group need to adhere to a consistent naming system to prevent confusion within the culture.

One commonly observed pattern in folk taxonomy is that of binomialization (Berlin 1992). Hunn and French (1984) hypothesized that an increased use of binomial names in a culture was directly related to the expansion of number of organisms to be named while Brown (1985) suggested that binomial names were used to label less salient organisms and uninomial names for highly salient organisms. A binomial name generally comprises a category name at the superordinate level and a modifier of some sort (Hunn 2006) such as an adjective. The current binomial nomenclature that biologists use is actually a modification of the "noun adjective" or "adjective noun" naming systems that are so commonly used in many human societies (Berlin 1992, Knapp *et al*. 2004, Stevens 2002). The prevalent use of nouns and adjectives by humans may be due to something that is deeply rooted in human nature. Waxman (1991) found that for very young children, nouns show taxonomic relationships at the higher order and adjectives highlight differences at lower order taxonomic units. Therefore, it is little wonder that "noun adjective" or "adjective noun" naming systems are so commonplace in human societies.

So, our question in this work is: what is the current taxonomic skill level of college students in an American state university? This paper presents the results of a class exercise that was conducted as part of the botany segue (introduction to botanical sciences) of our introductory ethnobotany course at the University of Hawai`i in fall 2007. The exercise was adapted from an informal class exercise that Berlin (1992) conducted in his ethnobiological classification class where students were tasked to classify a collection of museum skins of Amazonian birds. We implemented a similar class exercise using fresh plant materials collected from the vicinity of our university campus. While the foremost intention of the exercise was to introduce the general concept of plant taxonomy to non-science majors, we were also interested in finding out how our non-science majors would name and classify plants. We therefore hypothesized that these students would exhibit similar patterns to Berlin's (1992) students when it comes to naming and categorizing plants in that certain categories of words such as nouns and adjectives were used more often than others. In other words, we hoped to determine if "noun adjective" or "adjective noun" naming systems would be common among these students.

Methods

Participants

Students over age 18 who registered for the introductory ethnobotany course at the University of Hawaii in fall 2007 participated in this experiment after having given their informed consent. (Students under age 17 participated in the class exercise but their data was not collected.) A total of 95 students from 9 sections participated and had their data collected in this class exercise. About 98% of these students were undergraduates with freshmen (17%), sophomores (31%), juniors (31%), seniors (19%), and others (2%). Ethnically, about 71% of the students were members of minorities (Figure 1).

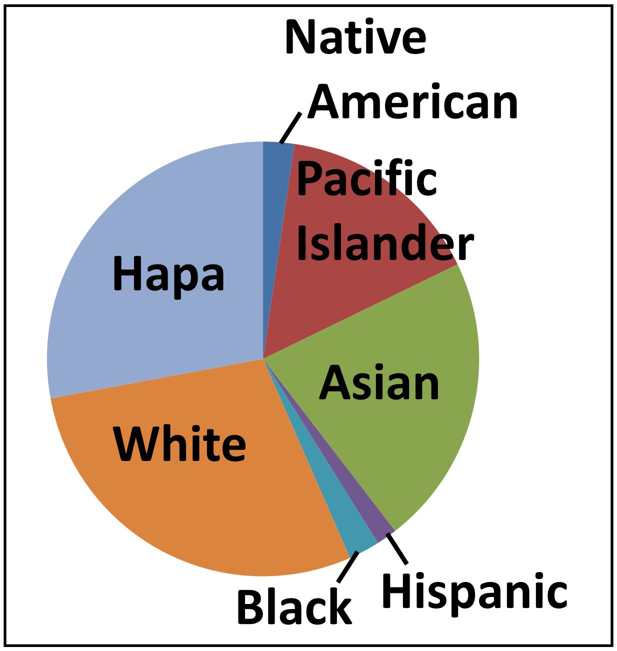

Figure 1. Ethnic distribution of fall 2007 introductory ethnobotany students. "Hapa[1]" is the local Hawai`i term for mixed racial background.

1. Hapa means "1. Portion, fragment, part, fraction, installment; to be partial, less. 2. Of mixed blood, person of mixed blood." (Pukui & Elbert 1986). This word is a transliteration of the English word, half, and when applied to people, originally meant those of part-Hawaiian ancestry. In modern parlance, it has been applied to any person of mixed blood, ethnicity, or blood (depending upon which category you prefer). Since more than half of the marriages in Hawai`i are between people of different ethnic categories, it would follow that there are many hapa in Hawai`i. The term has extended itself to the mainland U.S., and embraced as a term of pride through a book, Part Asian, 100% Hapa by Kip Fulbeck (2006), which is the result of an exhibition of portraits with the same title which was first exhibited at the Japanese American National Museum (Los Angeles) in 2006.

Materials

Forty plants (see Appendix 1 and supplementary Microsoft Excel spreadsheet, botany_segue_2007.xls) were collected from the vicinity of university campus and used as stimuli in this class experiment. Only fresh plants were used in this exercise, and the same plant species were consistently used for all class sections. The plants were selected to include a wide range of texture, shapes and colors. As such, the visual cues available to the students were the physical characteristics of the plants and the physical arrangement of the plants in the classroom. All forty plants were made into herbarium specimens and deposited at the University of Hawai'i Herbarium (HAW).

Procedures

During the 13th week of the course, fresh plants were collected every morning from the same source individual just before each class section to ensure that students were looking at fresh materials. All of the plant materials, except for fruits and tubers, were put in standard jars filled with water to keep the plants from dehydrating. Once plants were collected, they were randomly sorted and set out in a series of five rows of eight plants on class lab benches. A number was assigned to each plant numbering from the front to the back of the classroom (Figure 2), and the same number was used for the same plant for all class sections with plants arranged in the exact same configuration. This was important in that it allowed us to maintain a certain level of consistency across all class sections.

For each class section, students were asked to organize themselves into groups of three to five people. Each group was tasked to give each of the forty plants a name of their desire. Groups were to discuss and reach a consensus on the name and not to use already known names. It was made clear that the point was not to test their ability to apply actual common or scientific names to the plants but to develop a meaningful system for naming the plants that they could use themselves. We provided students with 4x6 index cards to record the names of each. After that, students were asked to organize the plants into categories based on their own classification scheme using a standard card sorting exercise (Bernard 2000). The entire exercise including receipt of directions and discussion of the results took less than 45 minutes. The key point here was that students were given complete autonomy in the naming and classification process. Lastly, data from all sections were consolidated and entered into a Microsoft Excel spreadsheet for analysis.

Figure 2. An example of plant material that was used in the class exercise. Note that a number was assigned to each plant material.

Results

Thirty groups of students participated in this class experiment. These students came up with a total of 1,171 names (see supplementary Microsoft Excel spreadsheet, botany_segue_2007.xls) for the 40 plant materials. An example of a student classification system term types is provided in Table 1. The choice of words used to name plants and categories was dependent on the vocabulary of the students and ranged from being fundamentally descriptive to entirely foreign. Technically, the students should have come up with 1,200 names. The discrepancy was due to certain groups of students not naming all of the 40 plants as instructed during class. Lastly, the students came up with 238 higher level classification categories for the plants (see supplementary Microsoft Excel spreadsheet, botany_segue_2007.xls).

Table 1. The percentage of names and categories that contain a particular term type. N.A. denotes that the term type is not used. (Note that the numbers in each column do not add up to 100% because a name or category may comprise more than one term type.)

Term Types	Names (%)	Categories (%)
Adjectives	42.6	41.8
Plant parts	24.9	26.5
Animal/human parts	10.2	1.6
Food, beverages & food plants	10.2	2.0
Animals	8.7	3.2
Plants	7.7	4.0
People	7.4	0.8
Tools and utensils	7.1	1.2
Unknown	6.5	8.0

Term Types	Names (%)	Categories (%)
Natural inanimate objects	6.2	2.8
Names	5.9	2.8
Phrases	4.0	0.8
Actions	3.8	2.4
Plant types	3.2	5.6
Explosives	2.6	0.4
Fabrics	2.3	N.A.
Descriptive	1.9	12.4
Events	1.7	0.8
Sports	1.7	0.8
Excrement	1.6	0.8
Constructions, inventions & technologies	1.6	N.A.
Places	1.5	1.2
Musical instruments	1.3	0.4
Medicine & medical conditions	1.3	N.A.
Decorations	0.9	0.8
Experiences	0.8	N.A.
Hairstyles	0.7	N.A.
Exclamations	0.4	N.A.
Cosmetics and toiletries	0.4	N.A.
Vocations	0.3	N.A.
Art	0.1	N.A.
Associations	0.1	N.A.
Microorganisms	0.1	N.A.
Military operations	0.1	N.A.
Song title	0.1	N.A.
Sound	0.1	N.A.
Punctuation marks	N.A.	0.4
Titles	N.A.	0.4

The number of terms used for plant and category names ranged from 1 to 12 and 1 to 5 respectively (Table 2). About 25% of the plant names were in monomial form and 52% in binomial form. The remaining 23% had names that consisted of 3 to 12 terms. The sharpest decline in the number of terms used in names occurred in names with 4 terms or more. On the other hand, about 61% of the category names were in monomial form and about 32% in binomial form. Category names that consisted of more than 3 terms were very uncommon. We also did not see many instances where students in different groups generated identical plant and category names. Singular and plural nouns were considered as being the same in this case. Only 54 (4.6%) of plant names assigned were identical. Thirty seven out of 54 names were repeated twice. The remaining 16 plant names were repeated between 3 and 5 times. The most often used name was "purple trumpet" which was independently used by 8 groups. As for category names, only 16 (6.4%) category names had names that were identical. Nine out of 16 names were repeated twice. The remaining 5 category names were repeated between 3 and 5 times. The most often used elements of names were "flower" and "fruit", and both names were independently used by 6 groups.

Table 2. Number of terms used in names and categories created by students. The students created a total of 1171 names and 238 categories.

Number of Terms	Names (%)	Categories (%)
1	24.8	60.5
2	51.6	31.9
3	15.8	5.9
4	4.3	1.3
5	1.3	0.4
6	1.1	0.0
7	0.5	0.0
8	0.2	0.0
9	0.2	0.0
10	0.3	0.0
11	0.0	0.0
12	0.1	0.0

We classified the plant and category names into different term types based on words used in the names (Table 1). Many of the plant names, with the exception of the monomials, were comprised of different term types. Forty term types were used for plant names while 24 were used for category names. The most popular term type that students used to name plants was "Adjectives". "Adjectives" were used in 42.9% of the names. "Plant Parts" (24.8%) and "Animal/Human Parts" (10.2%) were the next two most popular term types used by students. Similarly, the most popular term type used in category names was "Adjectives" which was used in 41.8% of the categories. "Plant Parts" (26.5%) was also the next most popular term types used by students but "Descriptive Nouns" (12.4%) replaced "Animal/Human Parts" as the next popular term type. The term type "Names" included names of people, religious figures, places, brands, countries, entertainers, and mythical, computer game, story, cartoon, comic and movie characters. We thought this would be a popular term type but only 5.9% and 2.8% of plant and category names respectively used this particular term type. Students also came up with terms that had unknown meanings. We define unknown terms as words that are not found in Merriam-Webster Online Dictionary or a Google web search. Only 6.5% and 8.0% of plant and category names respectively used terms that had unknown meanings. The remaining term types listed in Table 1 were self-explanatory and showed the diversity of vocabulary on the part of the students.

Since adjectives and plant parts were heavily used in naming and categorizing plants, we classified the adjectives and plant types into sub-categories to find out which adjectives and plant types were most popular. Table 3 lists the different types of adjectives that students used. Color was the most popular adjective used in plant names with texture being next. About 43% of the adjectives used were related to color. On the other hand, students preferred to reference the general physical condition of the specimens (30.2%) more than color in category names. Incidentally, texture (17%) was also the next popular adjective used in category names. Taste was the only adjective that was used in plant (2%) and not in category names. In the case of plant parts, students had consistently relied on leaf, flower and fruit in naming plants and categories. Table 4 lists the different plant parts that students used. Of all the plant parts, terms that were related to seed, bud and bark were not used at all in category names. These were also terms that were not very popularly used in plant names.

Table 3. The frequency of adjective types used in names and categories. A total of 541 and 106 adjectives were used in names and categories respectively. N.A. denotes that the adjective type is not used.

Adjective Types	Names (%)	Categories (%)
Color	43.3	11.3
Texture	16.3	17.0
Size	12.4	14.2
Shape	6.7	6.6
Physical condition	5.7	30.2
Feeling	4.3	11.3
Quantity	3.7	2.8
Pattern	3.5	3.8
Taste	2.0	N.A.
Smell	1.5	0.9
Ethnicity	0.6	0.9
Location	0.2	0.9

Table 4. The frequency of plant types used in names and categories. A total of 302 and 66 plant part terms were used in names and categories respectively. N.A. denotes that the adjective type is not used.

Plant Parts	Names (%)	Categories (%)
Leaf	33.1	34.8
Flower	31.1	28.8
Fruit	19.9	24.2
Stem	6.0	4.5
Branch	3.6	3.0
Seed	2.3	N.A.
Thorn	1.7	1.5
Root	1.3	3.0
Bud	0.7	N.A
Bark	0.3	N.A

Discussion

The concept of binomial nomenclature was not introduced to the students during class but about 51% of the plant names were in binomial form. We cannot discount the fact that these students may have learned of binomial nomenclature from somewhere (particularly from use of scientific and other cultural binomials within earlier portions of this course) but this result was highly suggestive that many students found it useful to use binomials to name plants. Many of the binomials were to make the names a lot more descriptive than if only a single term was used. For example, instead of just naming a plant "horn", students often added an adjective to it to further emphasize the physical appearance of the plant material. Examples of such names included "red firecracker", "purple horn", "bleeding leaf", "brown rock" and "long dirty ball". On the other hand, monomials were used more often than binomials for category names. This seemed to suggest that students found it helpful to use single term to summarize the general characteristics of exemplars belonging to a particular category. The use of a second term in category name was, in many cases, only to be a little more specific about attributes associated with the categories. For example, "short leaf" was used to differentiate among plants with just "leaf" or "big leaf". Hence, whether this was an indication that our students were consciously trying to achieve a certain level of economy of memory by reducing the number of terms used at the category level or not, we could take comfort in the fact that a great majority our students did not take delight in developing long and unwieldy names. It was clear from Table 2 that long names were unpopular among students. The longest plant name was "single bladed long leaf flowering flower nodes (white), floral smell, multiple small leaves" which consisted of 12 terms. The name was provided by one particular group of students that generally named plant materials by using relatively long descriptions. This group was also the only one that did not categorize the plants. The most plausible reason for that was the group did not have enough time to complete the exercise – only 30 out of the 40 plant materials were named. There was one more group that only named 30 plants but unlike the previous group, this one did not use long names and was able to categorize the 30 plants. The evidence might be weak but it seemed that most students understood the trade-off between long names and time efficiency.

Another interesting finding from this experiment was that students used many adjectives and terms related to plant parts to name plants and categories. The result was that the plant names were rather descriptive even though at times, it was unclear if the descriptions really fit the actual physical appearances of the plants or just what the students felt the plants resembled. Nevertheless, students were evidently trying to develop some inferential relationship between plant names and the plant materials. For example, the most often used name was “purple trumpet”, a name that was independently used by 8 groups of students to describe *Pseudocalymma alliaceum* (Lam.) Sandwith. Not surprisingly, the flower of this plant was purple in color and had a shape that resembled a trumpet. Other names used to describe this plant included “tea cup”, “pink cup” which hinted at the flower having a cup-liked shape. However, not all names were as revealing and allusive. The same plant had also been named as “royal bulbs”, “canal”, and “purple people eater”. While we did not quite understand how *P. alliaceum* might eat people, we thought these imaginative names were reflections of how students felt about the plant. Another example was *Colvillea racemosa* Bojer. Names given to this plant material included “fireworks”, “fire blossom”, “sun explosion flower” and “brightly colored flower”. Most of the names understandably alluded to the bright and fiery display of the plant’s inflorescence but there were some that were quite baffling such as “red-headed stepchild.” It was unclear as to how the students would relate a phrase with such deep and dark connotations to the plant’s inflorescence. Nevertheless, these plant names were basically the results of students’ cognitive constructive processes. In the case of category names, many of the names were rather straight-forward in that the names were quite self-explanatory. For example, the most often used category names were “flower” and “fruits”. Other common category names included “animal”, “berry”, “edible”, “floaters”, “water”, “colored leaf” and “water plants” which were equally self-explanatory. We also found category names that were quite baffling such as “TB”, “asterick”, “barbie”, “oral fixation” and “special ed”. Nevertheless, as in plant names, these categories were constructed based on perceived features of the plants and conceptual knowledge of students.

Of all the adjectives used, color was used most often by students to name plants. We attribute this to the fact that color was a prominent physical feature, and students found it easier to differentiate color variation as long as they were not color challenged. A breakdown of all the colors used showed that purple and red were the two most popular colors referenced by students. The two colors were found on flowers and fruits of 17 (42.5%) plants. On the other hand, thirty four (85%) of the plants specimens had the color green on them - mainly the leaves, but students did not use the color as much for names. This suggests that students did not select a color simply because the color was there but they were consciously selecting the color of distinctive and less mundane features of the plant materials such as fruits and flowers. Consequently, they were naming plants based on those same distinctive features. Interestingly, students did not use color as much as when it came to naming categories. Instead, students preferred to use terms such as “leafy”, “edible”, “colorful”, “useful”, and “floating” that described the general conditions of the plants. These general terms were rather inclusive, and it was evident that students were consciously choosing category names that would facilitate the making of predictive inferences about exemplars within the categories.

Besides adjectives, the students also used plant part terms in the naming and categorization process. Students mainly used terms that were related to leaf, flower and fruit for both plant and category names, and we wondered if this was mainly due to their limited botanical vocabulary. None of these students were botany majors and so, their deficiency in botanical terminology was both understandable and highly probable. On the other hand, this consistency might have been a direct result of the plant specimens used during the class experiment. It would be hardly surprising that leaf-related terms were frequently used when most of the plant materials actually had leaves. In fact, 35 (87.5%) and 21(52.5%) of the plant materials used had leaves and flowers respectively. Only 5 (12.5%) of the plant materials had only fruits. If the frequency of plant-part terms used in the naming process was directly related to features found on the plant materials, then we should see students using less of terms relating to fruits and more of those relating to branches because 25 (62.5%) of the plant materials had branches. The reason for the limited use of branch-related terms could be that branches were not as prominent a feature as leaves, flowers and fruits. Branches of plant specimens were generally inserted inside jars to hydrate the plant materials. This could have resulted in students overlooking the branches and paid more attention to other more prominent features such as fruits. So, we felt that students were not limited so much by their botanical vocabulary but the visible features of the plant materials. Moreover, by using plant parts, the students were already defining categories based on shared properties. In other words, the students were essentially selecting distinctive physical characters of the plants when they named and categorized the plants by using plant parts.

The tendency of our students to use adjectives and plant parts for names might have resulted in fewer instances where actual names of people or places were used in this class experiment. As shown in Table 2, only 5.9% and 2.8% of the plant and category names respectively actually used names of people, places, countries or story characters. We believed that students found it difficult to identify the plants to actual names because they were not able to establish a logical relationship between the two. For example, two groups of students named *Aleurites moluccana* (L.) Willd. "O Canada" while the rest of the students thought nothing more than the leaves showing some resemblance to those of the maple or "little foot" a reference to a popular dinosaur movie from their common childhood. Only those two groups decided to establish the relationship between maple leaf and the flag of Canada while the remaining groups were either oblivious to the fact or simply chose not to make the connection. Either way, prior knowledge of a subject was needed to be able to effectively use actual names to name plants and categories. The lack of use of actual names among our students seemed to suggest the limited general knowledge of the students or just the lack of motivation to move beyond the simple task of just describing a physical object.

Interestingly, we did not encounter many instances where students came up with identical names for plants and categories. This might be due to the fact that students came from a myriad of cultural and knowledge backgrounds and the names they generated were reflections of their individual and group minds' interactions with the visual cues in the classroom. For example, names that were given to eggplant included "purple limp stick," "grossly rubbery hook," "shoe horn fruit," "eggplant," "oblong," "purple fruit," "purple looking plant" and "slug". Clearly, different thoughts were going through the minds of the students; some saw the eggplant as food while others saw it as a gastropod or a hook. In other words, not all students thought of eggplant as food. Students who did not enjoy eating eggplant or were simply being creative might see it as something inedible and hence "limp stick" or "rubbery hook". It was due to these different interpretations of plant materials that students were able to come up so many non-identical names. In fact, one even named it "Just get it over with."

Anecdotal evidence indicates that many non-science majors who enrolled in science classes are poorly motivated (Arwood 2004, Druger 1998). Unfortunately, the answer to what motivates non-science majors to learn science is unclear due to lack of research focused on this area (Glynn *et al*. 2007). Glynn *et al*. (2007) therefore conducted an experiment to address this issue and found that students became motivated if they saw the relevance of science to their careers. We have reasons to believe that students who participated in our class experiment are generally motivated because results from our course survey conducted at the end of the semester showed that about 93% of the non-science majors loved the course. We attribute such positive feedback to the fact that this introductory ethnobotany course was conducted as a series of segues or transitions where each segue is used as a mechanism to introduce students to a different science while studying the particular science of ethnobotany. Examples that are encountered in daily life are frequently used in class to help students see the relevance of science in their everyday life. Therefore, we feel that motivation has not affected the results of this experiment.

Conclusion

Students are basically well aware of the different functional roles of plant and category names and illustrated this frequently by using binomials consisting of noun-adjective combinations to name plants and mononomial nouns to name categories. This is evident from the subtle differences that students show in naming plants and categories. Categories are formed based on students' perceptions of the plant specimens in a classroom setting. The different perceptions result in the creation of many unique plant and category names which suggest a diversity of thoughts taking place in the classroom. More importantly, the plant and category names are formed as a result of similar constructive process on the part of the students. Our next question is if we would observe similar patterns in subsequent class experiments. For example, will students in subsequent courses use more binomials for plant names and monomials for category names, and will adjectives and plant parts be used more in both plant and category names? A similar experiment can also be conducted in a different setting such as a garden to see if students' responses are directly affected by where the experiment is conducted. Also, different groups of students such as high school students can be included in this experiment to see if there is a difference between college and high school students. Another experiment is to have students from other parts of the world perform the same exercise and have the result analyzed for emerging trends on how students of different political and cultural backgrounds assign names to plants categories. A potential outcome of such collaboration across the globe is that the data collected may help to provide insights into human categorization process.

Open Invitation

We end this paper with an open invitation. This project started out as a simple class experiment for a college introductory course, and the same class experiment will be conducted for the next few years when the course is being offered. The experiment is simple and straight-forward in nature but the amount of data collected is immense given the short amount of time required to conduct it. Here, we present results from our first semester of data, but in addition to that, we wish to develop this project into an "open project" that facilitates the extension of the project into different research areas by other researchers. We believe that it is through open-sharing and open-collaboration that we can improve the quality of our research.

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Appendix 1. Plants species collected from the vicinity of university campus and used as stimuli in this class experiment to explore student knowledge about taxonomic nomenclature.

1. *Codiaeum variegatum* (L.) A. Juss.
2. *Nephrolepis exaltata* (L.) Schott
3. *Azolla filiculoides* Lam.
4. *Eichornia crassipes* Solms
5. *Capsicum frutescens* L.
6. *Ipomoea batatas* (L.) Lam.
7. Graptophyllum pictum (L.) Griff.
8. *Acalypha hispida* Burm. f.
9. *Couroupita guianensis* Aubl.
10. *Colvillea racemosa* Bojer
11. *Solanum tuberosum* L.
12. *Bixa orellana* L.
13. *Coleus blumei* Benth.
14. *Myoporum sandwicense* A. Gray
15. *Pseudocalymma alliaceum* (Lam.) Sandwith
16. *Acalypha wilkesiana* Müll. Arg. (reddish leaves)
17. *Cuphea hyssopifolia* Kunth
18. *Brassica oleracea* L.
19. *Alpinia purpurata* (Vieill.) K. Schum
20. *Aleurites moluccana* (L.) Willd.
21. *Lecythis minor* Jacq.
22. *Euphorbia milii* Des Moul.
23. *Pseuderanthemum atropurpureum* (W. Bull) Radlk.
24. *Mentha arvensis* L.
25. *Odontonema tubaeforme* (Bertol.) Kuntze
26. *Acalypha wilkesiana* Müll. Arg. (variegated leaves)
27. *Chenopodium album* L.
28. *Scaevola sericea* Vahl
29. *Gossypium tomentosum* Nutt.
30. *Solanum melongena* L.
31. *Pistia stratoides* L.
32. *Coffea arabica* L.
33. *Cyperus papyrus* L.
34. *Asparagus officinalis* L.
35. *Ochna thomasiana* Engl. & Gilg
36. *Couroupita guianensis* Aubl.
37. *Phymatosorus scolopendria* (Burm. f.) Pic. Serm.
38. *Tithonia diversifolia* (Hemsl.) A. Gray
39. *Heliconia rostrata* Ruiz & Pav.
40. *Pseuderanthemum carruthersii* (Seem.) Guillaumin