Chapter 5

CIDER HOUSE LEARNING; EDUCATION BASED ON TASTE AND SMELL

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ABSTRACT

Apples (Malus pumila Mill., Rosaceae) were chosen for study as model plants that are widely familiar to students in the US and because a number of distinctly different varieties are commonly available. This links to our interview data from cider makers on four continents regarding their knowledge and classification of apples. The interview results showed that many multigenerational cider makers applied experiential knowledge such as tasting rather than mere observations of plant morphology in order to identify the plants with which they worked. They apply classification schemes for apples based on taste and texture that are useful for blending of cider. The cider makers’ classification of apples is strikingly different from modern botanical classification typically taught to students which focuses on morphological features and not smells or tastes. The lessons learned from cider makers were then applied to the classroom. A curriculum was developed that substitutes experiential for observational learning, thus mimicking traditional learning. Measures of both student learning and course satisfaction improved with the implementation of this alternative strategy. We hope to help education through the development of experiential-based, science-education curricula by focusing on traditional knowledge involving basic senses such as taste and smell.

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INTRODUCTION

Sensory Ecology

Remember the taste of your favorite apple (*Malus pumila* Mill., Rosaceae) (or other fruit) as a child. Recall the smell of the fruit as you took your first bite and the texture as you chewed a mouthful. To many of us, this mental exercise brings back a flood of memories and images. These attributes are important details about apples. This wide range of sensory information is not limited to apples, of course. Studies of sensory ecology and chemosensory perception of the biological world have shown that the classification and identification of plants are often done by smell and taste (Berlin 1992, Gollin 2001, Leonti et al. 2003, Shepard 1999). Berlin (1970) discusses an informant who, during a field interview, stopped at trees, cut off some of the bark, held them up to his nose and smelled, then tasted them, and then proceeded to say the names of the trees. Much research has been done looking at this idea of wild plant selection and uses based on sensory perception (taste, smell, texture) and evaluation, though this is largely done with medicinal plants (Bennett 2007, Crivos et al. 2007, Shepard 2004). Much less work has been done looking at plant selection for food or drink based on identification by taste or smell (Jernigan 2008, Pironi et al. 2002, Reedy et al. 2009).

Human tongues have taste receptors which detect the five basic tastes of bitter, salty, sour, sweet, and umami (Goff & Klee 2006). These tastes vary between and across cultures (Pironi & Torry 2007). Moreover, these profiles have different meanings to different cultures (Wright et al. 2001). Shepard (2004) explains that “sensations can be understood as bio-cultural phenomena rooted in human physiology, but also constructed through individual experiences and culture.” The result is that interpretations of individual tastes and combinations of tastes are inconsistent between cultures and what is considered as desirable traits varies widely.

When a food plant tastes bad we tend to not eat it (Birch 1999). Food aversion is a learned process and is largely associated with taste (Baker et al. 2007, Meadows 2009). Animals learn about toxicity from the taste of a plant (du Toit et al. 1991), but they also learn about major nutritional aspects of a plant by the taste (Goff & Klee 2006). Nutritional information is thought to be due to flavor-related volatiles that are released from the essential nutrients (Goff & Klee 2006). Flavor and taste have been shown to be separate, though
linked, senses. Flavor is perceived as taste, though it is a combination of taste and smell (Cullen & Leopold 1999). Recent research has shown that a sense of taste is a better remembered sensory perception than is a sense of smell (Laureti et al. 2008).

Having a taste memory has evolutionary advantages. Conditioned Taste Aversion (CTA), a type of taste memory, is the process we go through when we eat a new food and associate any resulting bad experience with the taste of that food (Bermúdez-Rattoni et al. 2005). Building a rich set of CTA memories helps us survive. It is the combination of positive and negative associations with food plants that plays an important role in our selection of food (Clark & Bernstein 2009, Favreau et al. 2010, Núñez-Jaramillo et al. 2010).

ON BITTER AND CIDER

Our CTA memory relative for bitter taste and bad experiences seems to be able to be overridden in relation to medicine. This idea of an aversion towards bitter also seems to be nullified in the human desire for bitter food and drink (Drewnowski 2001), especially traditional cider (McClatchey & Reedy 2010). Cider apples, the varieties of apples specifically grown to ferment into cider, are commonly classified by their principal tastes into four categories; bitter, bitter-sharp, bitter-sweet, and sharp (Umpelby & Copas 2002). These taste categories are for both the apples and the fermented cider, with more specific descriptions often added with more regionally-defined taste attributes such as acetic, acidic, and sour.

McAuliffe & Meiselman (1974) discuss sour and bitter tastes among their US Army informants as being confused terms. In our research, involving over 200 cider makers in twelve countries, there is a clear distinction between these two tastes. These cider makers have learned the process of working with apples which have these specific attributes and use these characteristics in the process of creating a fermented beverage. The cider maker may also be an orchardist who grows the apples needed to make the cider, although this is not always the case. As we will see below, the orchardists often keep track of the trees in their orchards using the taste principles from the fruit.
SENSORY CLASSIFICATION

Studies of folk taxonomy and conceptualized biological cognition have examined the sensory classification of plants as a phenomenon that is cross-cultural and scalable (Berlin 1992, Medin & Atran 2004, Medin et al. 1996). Berlin (1992) discusses the perceptually-based concepts that are used to name a taxon at a specific level compared to its generic counterpart. The generic name of a plant is the basic name (noun) assigned to it while the specific epithet is a modifier (adjective) that may be used to distinguish different kinds of the same generic plant that are considered to be otherwise similar. Among characteristics such as size, shape, color and smell, he states that taste often makes up the secondary or specific name of plants (Berlin 1992).


Our analysis produced a list of 795 named cider apples. Cider apple varieties with known synonyms were included in our list with each synonym included as a separate name. We reviewed the compiled list following the methods used by Lau et al. (2009) and decided upon eleven categories which best represent the types of names. The types are color, name (person and/or place), quality, quantity, shape, size, taste, temporal, texture, stylized name, and other attribute (See Table 1). Example names of apples in these categories are color (Redstreak, Red Foxwhelp, and Green Styre), name (Yarlington Mill, Bulmer’s Norman, and Langworthy), quality (Improved Hangdown, All Doer, and Never Blight), quantity (Fillbarrel, Clusters, and Abondance), shape (Pen Caled -- a Welsh name meaning Goose Head, Catshead, and Sheep Snout), size (Small Styre, Petit Jaune, and Dainty Apple), taste (Sweet Coppin, Spice Apple, and Wilding Bitter-sweet), temporal (Early Rouget, Honiton Early, and Winter Stubbard), texture (Greasy Butcher, Bastard Rough Coat, and Longney Russet), stylized names (Slack-Ma-Girdle, Ten Commandments, and Well Beloved), and other attribute (Upright French, Broom Apple, and Twist Body Jersey).

The summary of the 975 cider apple descriptors is reported in Table 1. The larger number of descriptors than named cider apples (795) is because
many apples have multiple descriptors coded into their names, such as Yeovil Sour, Northwood Bittersweet and Pennard Bitter. In these examples, both the preceding place name and the taste descriptor were counted. To further illustrate this, the 57 descriptors coded for taste had 40 had additional descriptors, either primarily or secondarily.

Table 1. Analysis of name categories of 795 individual cider apple varieties.

Varieties with multiple descriptors (such as Name and Taste) analyzed separately, resulting in a total of 975 given descriptors.

<table>
<thead>
<tr>
<th>Name Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>156</td>
</tr>
<tr>
<td>Name (Person or Place)</td>
<td>528</td>
</tr>
<tr>
<td>Quality</td>
<td>32</td>
</tr>
<tr>
<td>Quantity</td>
<td>9</td>
</tr>
<tr>
<td>Shape</td>
<td>19</td>
</tr>
<tr>
<td>Size</td>
<td>18</td>
</tr>
<tr>
<td>Taste</td>
<td>57</td>
</tr>
<tr>
<td>Temporal</td>
<td>20</td>
</tr>
<tr>
<td>Texture</td>
<td>9</td>
</tr>
<tr>
<td>Stylized Name</td>
<td>23</td>
</tr>
<tr>
<td>Other Attribute</td>
<td>104</td>
</tr>
</tbody>
</table>

Further analysis of the data in Table 1 goes beyond the 795 individual names given to cider apples by orchardists. When looking at the categories of names given we get a sense of how people classify the world around them. Although, the majority of varieties include a name of a person or place, it is interesting to look more closely at the 222 names that reference senses of touch, sight and taste.

As consumers, most of us have experienced buying an eating apple from a supermarket or grocery store where all the varieties have names. The names will be on a sign or a small sticker attached to the fruit. These fruit stickers also have a standardized numbered code which identifies the variety’s name. This works when selecting from a small pool of popular commercial varieties. But a different situation may be found in a small market, farm shop or even out wild harvesting since labels are not attached to the fruit. The names are important as they help us associate specific characteristics with the fruit.

The name and characteristic association become even more difficult for the person who is growing or harvesting a large number of apple varieties cope when they want to use a particular kind of apple but do not know a name for
it? To answer this question, we invoked the traditional Hawaiian imperative of *Nana i ke Kumu* (Look to the Source). From 2007-2010 the authors have been conducting field research with cider makers on four continents, asking questions about this very subject.

**METHODOLOGIES**

**Informant Selection**

Preliminary identification of possible informants was done with Internet searches for cider, cider makers, and cider making societies. This method of Purposive Sampling (Tongco 2007) was utilized to focus our efforts on individuals likely to have knowledge about cider apples. Invitations to collaborate in research were mailed to each identified cider maker. Responses to these invitations were received either by mail or e-mail.

**Interviews**

All interviews were conducted in local languages. Each informant was first orally presented information about the project goals. Consent was then requested to use an audio recorder and camera to record the interview and document information about cider apple varieties, orchard management, duration of orcharding, and cider production methodologies being used. Institutional Review Board (IRB) approval for this project was provided by University of Hawaii, Committee on Human Subjects (approval #17564).

**RESEARCH**

Reedy *et al.* (2009) documented our research in England, the North of Ireland, Wales and the Pacific Northwest of the continental United States. This study divided the knowledge transmission and education of cider makers into three categories. The categories are: 1) multi-generational cider makers who learned from a family member such as their father, grandfather, etc., 2) cider makers who have been making cider for more than 10 years, but did not learn from a family member, and 3) cider makers who have been making cider for
less than 10 years and did not learn from a family member. These categories differ a great deal from the widely accepted knowledge transmission categorization which is based on the directional of the transmission path (Reyes-Garcia et al. 2009). The reasoning for our emergent categories is that people who learn from books, classes and other non-familial methods are potentially exposed to a different way of learning and a more standardized set of vocabulary (Dolan 2007). The reasoning for 10 years being a separating factor lies in the onset of a global renaissance that surrounds cider in the late 1990s. We believe that our categories remain valid and we continue to analyze data from interviews with cider makers within these parameters.

How this relates to taste is a quite unexpected phenomenon. When someone decides, for whatever reason, that they want to be a cider maker, their first stop is often a visit to a local bookshop, do an Internet search, or take a class on how to make cider. They information on yeasts and fermentation, hygiene, and good orcharding practices. They also get lovely illustrations of the best cider fruits to use, all with names attached to the picture for proper identification. This concept of having proper names for cider fruit will continue as the cider maker produces his or her first cider, and proudly fills bottles and labels them with the names of the apples contained within.

But what happens when you are born into a cider making family and you grow up with cider apple trees, not books with pretty pictures and labels? What do you do when the tree does not easily offer up its name? Table 1 shows us the types of names given to cider apples. However our field research has shown that many cider makers do not know the names of the apples they use (McClatchey & Reedy 2010, Reedy et al. 2009) and, more importantly, they do not need to know the names.

The reason that names are not always important lies in the manner in which the long-term cider makers think about the fruit that surrounds them. These are orchardists who have learned the multitude of flavors that exist in this diverse fruit over a lifetime of working with cider apples. It is something that they have picked up over years of observations of flowering and fruiting, and how the apples have responded to different regimes of rain and sunshine. What these cider makes must do is to develop a strategy of mixing apple varieties based not on their taste now, but what their taste will be in 6 months. It is only then that the apple’s sugar has been digested by yeast and converted into alcohol. This is where the principles of bitter and sour come into play.

Drewnowski & Gomez-Carneros (2000) say that the phytonutrients that cause food to taste bitter are actually good for human health, although such properties are highly incompatible with market demands and consumer tastes.
Bitter as a flavor profile is expected, enjoyed or even craved to limited degrees in certain beverages (Drewnowski 2001, Paglios et al. 2009), such as beer, tea (*Camellia sinensis* (L.) Kuntze Theaceae), yerba maté (*Ilex paraguariensis* A. St.-Hil. Aquifoliaceae), and cider. To the cider maker, it is the bitter, sour, acidic and sharp flavors which define a cider apple much more than the taste of sweet ever could. The process of fermentation removes the sweetness, and it is the remaining acids and tannins that flavor the finished product. These cider-defining flavors are those that must be understood, much more so than the apple names and sweet tastes. This is the set of skills and taste-based learning we call a Cider House Education.

There are many things that are “named” by cider makers. These include their products, their farms, their animals (such as dogs), and obviously themselves as individuals. It is surprising that they would not also apply names to the specific kinds of apples that provide the essential resources for their livelihood. Many people do write down the names of the apples when they are planted, but there may be many generations that use these apple trees after they are planted. Many of the names are simply lost over time. For the cider maker, it is the taste that is important, not the name. When learning how to make cider, learning by sense of taste just makes more sense.

What does it mean to learn by taste? Taste functions as the framework for mixing the apples together when juicing them, or for mixing the juice when adding it to fermentation tanks, or when blending fermented juice into the finished cider. However, younger cider makers and those who did not learn from a family member are more prone to fermenting separate batches of juice from named apple varieties, and only mixing these juices when there is a need to finish filling a fermentation vessel. This is perhaps due to the manner in which these cider makers learned their craft and the structure of the orchard they harvest their fruit from.

The structural arrangement of the trees of more than 200 orchards has been analyzed (Lush et al. 2009). This shows that traditional orchards are more likely to be planted with varieties in alternate rows. Informants have expressed two benefits of intermixing the planting of different varieties; enhanced pollination for better fruit set and being able to begin the process of mixing good cider in the orchard through tasting different apples. They report that if one apple variety is harvested alone and the juice fermented, the results will not be as desirable as if starting with a blend of varieties which were harvested and juiced together to form the final blend. That blend is what gives each cider its individual characteristic taste and aroma. This is where the
experienced cider maker calls upon his or her knowledge and experience to make a good blend, albeit with different results, year after year.

The concept of blending apples before they ferment as opposed to blending after fermentation is something that separates different knowledge groups of cider makers. Biting into an apple and being able to forecast its taste after fermentation is something that requires years of experience to understand. This might only seem practical, or even possible, to someone who has learned to conceive of their orchard and its apples in a taste-sensory way. However, the cider makers coming into this world of taste and fermentation during adulthood need to rely on words rather than mental concepts for their sensory categorization.

Note the contrast: beginning cider makers rely on language to describe the characteristics of apples while the experts use their senses. From early childhood we learn to rely on words to enhance our memories. Terms such as mealy, tart and sweet are common to most of us. However, when we do not have an adequate vocabulary to describe what we sense, and we are predisposed to describing what we taste with words, we are limiting how we can record our sensory experience. This is what Melcher & Schooler (1996) describe as memory illusions. Memory illusions are what happens when someone’s “perceptual memory greatly exceeds one’s ability to communicate that memory” (Melcher & Schooler 1996). These illusions result in comparison taste analogies such as “tastes like chicken”, or in the case of cider apples “tastes a bit like a crab apple,” or “tastes like biting into an aspirin.”

It is these tastes themselves that go beyond each individual orchard. Each cider making region has distinct cultural tastes that determine how cider should be made and what it should taste like when finished. For example, England is known for its characteristic bitter, dry still cider; France for its sweeter, fruitier, bitter-sharp sparkling cider; Germany for its light yet acidic cider; and Spain for its more acetic almost vinegary tasting cider (Alonso-Salces et al. 2004, BJCP 2008, Morgan & Richards 2003, Proulx & Nichols 2003).

Regional taste preferences determine which cider apples each cider maker chooses to cultivate. There is, however, much debate whether local varieties define local taste preferences or if taste preferences were used as the parameters for selecting varieties to cultivate locally.
TASTE-BASED CONSERVATION

Globally, there are approximately 47,000 hectares of cider apple orchards conserving the diversity, both genetic and taste, of cider apples (this approximation is based on data from Merwin et al. 2008, Portman 2008, Williams 1988). These orchards are filled with apples which are not grown for the eating apple in your lunch box, the ones kids used to polish and put on their teacher’s desks, or even the ones with razorblades in them on Halloween. These apples are grown solely to make ciders which have specific tastes. This conservation of habitat and diversity based on taste, or Taste-Based Conservation, has motivated several governments to act. Traditional orchards, the type of orchard many cider makers cultivate, are now recognized in parts of Europe as being habitat for wild flora and fauna (Wedge & Robertson 2007). There are funds available in the United Kingdom to aid in restoration and maintenance of these types of orchards (Lush et al. 2009, UK BAP 2008). In Italy, and other parts of the European Union, there are funds available to cultivate and maintain traditional varieties, including the varieties used locally to make cider (European Commission 2002, Regione Campania 2009, Savo 2009). However, taste-based conservation goes beyond preserving habitat for wildlife and genetic diversity of tree fruit crops.

Rose Grant, a cider maker in Dorset, shared a story that illustrates the fundamental basis of taste-based conservation. A few years ago, Rose was walking her dogs through a nearby woodland in Lydlinch Common. She noticed several apple trees growing together and, being a curious person, she pulled some of the apples down from their branches and tasted them. Most of the apples were not appealing, being too bland or watery. However, one was much to her liking. It had a complex, mild bitter-sharp flavor. She took a few cuttings from that tree and after returning home grafted them onto half-standard rootstocks. After asking some community members near the woodland she found out that these trees were not part of an old orchard but were part of a staging ground for the D-Day invasion during World War II. The apples growing there were apples that grew from seeds lodged in apple cores discarded by American servicemen in the days before the invasion. In the Fall of 2010, the local electricity company cut down the original tree, leaving the cuttings that Rose took to be the only genetic link to the story. The survival of this otherwise unknown variety is based solely on taste, not of an apple ready to eat straight off of the tree, but an apple that needs to be processed into a cider for its inherent qualities to shine.
Rose is not alone in saving trees because of their taste, or even in wild harvesting feral apples.

One orchardist in Italy showed us an apple tree he was growing. As he approached the tree his eyes lit up. He told us that the tree was the only one that he knew of its kind. During the interview we asked him why he continued to grow this tree. His answer was that it was a favorite apple of his from his youth (rather than that it was a rare tree). He could not part with the flavor, so he kept this one tree in the middle of his orchard of more modern and recognizable apple cultivars.

One cider maker in Eastern Washington detailed his passion for complex and rare tastes in his cider. He told us about his frequent trips into woodlands surrounding his Yakima area orchard. He has come across several feral apple trees in these woodlands which are grown from pips transported there in the bowels of deer. Apples do not usually reproduce true from seed due to self-incompatibility, meaning that any viable seedling will most likely not resemble the parent variety (Juniper & Mabberley 2006). Each new seedling has the potential for new flavors which are wait to be tasted.

Most of the newly encountered apples are bland and flavorless, just as reported by Rose Grant. However, there is an occasional new variety with a taste that strikes a cider maker as good enough to include in his cider. The idea is that even though the fruit is an unknown variety, there is an expectation of what the fruit will or should taste like based on earlier encounters with similar fruit. Köster et al. (2004) discusses these interactions as being Explicit Tastes. Perhaps this is the mechanism employed by cider makers and medicinal plant users when finding new varieties and deciding what to do with them.

**TASTE IN THE CLASSROOM**

Taste seems to be an essential aspect in the realm of conservation of plants, and in turn animals, as well as the education of cultural practitioners in both cider making and medicinal healing. We went into the field to understand how these practitioners are taught and the way they learn. But how can we as botany and ethnobotany educators teach this to students? Our brains are wired to record all the sensory characteristics as we bite into an apple. We remember its taste, smell, texture and other characteristics and then link this information to the apple’s visual cues. Modern classroom based education has promoted a
different set of skills, such as rote memorization of scientific binomials. These are not hardwired into our human “survival kit.”

Auer (2008) argued that taste and other senses “are means for breaking down dualistic conceptions of ‘people’ and ‘nature’ in environmental studies, particularly in outdoor contexts.” However, this observation was geared towards outdoor education of children, not botanical classroom education. Botanical textbooks, such as Judd et al. (2008), largely teach students to focus on morphology in order to identify plants. Students are taught to look at placement of leaves and reproductive parts, and the existence of bracts, sepals, or tepals. Other important features such as stamen or anthers need to be counted and the number or the result of any number that is odd or even gives important clues to the identity of the plant. These floral formulas, and their subsequent sets of rules and exceptions to rules, need to be memorized for each of the 415 flowering plant families that occur on our planet. In order to aid in this massive undertaking, students are taught how to use microscopes and dichotomous keys to further narrow down the plant’s identity. Needless to say, this sort of rote memorization of morphological characteristics leads to frustration and stress among many an undergraduate botany student.

SEGUES TO SCIENCE

In the Fall of 2006, a curriculum-based project titled Ethnobotany Segues to Science (informally called “Segues”) was initiated at the University of Hawai‘i at Mānoa (Lau et al. 2009, Savo et al. 2009). One of the courses to implement the Segues curriculum was Introductory Ethnobotany. The idea of this project was to teach students about other scientific disciplines, but in ways that maintain their relevance to culture. This involved bridging (or segueing) from class discussions on one scientific subject to the other scientific subject at natural segue points. For example, during a discussion about the ethnobotany of fermented foods, students were introduced to the discipline of mycology through a short exercise examining effects of different kinds of fungi on food plants.

Students were encouraged throughout the Segues project to use any tools at their disposal, not just microscopes and dichotomous keys, to understand the world of plants that surrounds them. On multiple occasions this included tasting plants and processed plant material. Two such classroom exercises are described below.
**BOTANY**

Instructors collected 40 different plant species from around the university campus during the botany portion of the Segues to Science project. These plants were placed on lab benches spread throughout the classroom. Students were instructed to work as a group of two or three people to come up with names for all 40 plants. The instructions were to be “as creative as they desired, make up names that made sense to them.” Further, if any student knew the actual name for a plant, they were told they could use the known name or could avoid it and create new name (Lau *et al.* 2009, Savo *et al.* 2009).

Students then proceeded to look at each of plant, make observations about the color or shape, then let their other senses take over the task. They began pulling off leaves and flowers, crushing them between their fingers and smelling them, making notes on the odor and aroma of the plant. Many chose to write names relating to the texture of the plant materials. Without any warning or caution, some students also tasted the plants, not knowing if they might be poisonous. Students, on their own, elected to use their sense of taste, among other things, to classify plants in a university science class.

**CHEMISTRY**

During the chemistry portion of the Segues to Science project, instructors prepared a setting in an outdoor environment with a set of plants used as beverages. This was an opportunity to discuss the chemistry of beverages of different types (such as solutions, suspensions, or colloids). A specific exercise was conducted with students sitting in a garden area, in a circle on mats. As they sat down, one instructor began preparing fresh ‘*awa* (*Piper methysticum* G. Forst.) by squeezing crushed clean plant roots in fresh water to form a brown suspension. As the students watched the ‘*awa* being prepared, they were informed about the history, biogeography and botany of this beverage plant by their instructor. While the instructor was still discussing the social and communal aspects of the ritual of drinking the prepared ‘*awa*, an assistant passed bowls of the drink out to each person in the circle. Students drank the liquid and shared stories about their favorite things in life and tastes of their favorite foods.
Next, test tubes that had been filled in front of the students with the same liquid were passed out to each person in the circle. Each student was provided with a small drinking straw. At this point the discussion shifted to the chemistry of the ‘awa plant and the beverage in their hands. The beverage, which is a colloidal suspension, settles into multiple distinct layers that are visible in the clear test tubes. Students were encouraged to use their straws to taste different layers of the suspension in the test tube. Students again discussed the tastes with each other and were surprised that such a wide variety of tastes (bitter, sweet, bland, fatty, watery, etc.) could all be extracted from the same roots and be suspended in a single liquid. The instructor then used this opportunity to discuss modern chemical analysis and encouraged students to consider exploration of chemistry as a career that explores the molecular complexity of the world.

**ASSESSMENT OF STUDENT LEARNING**

A total of 26 other scientific disciplines were presented to the students during the course of each semester in which the Segues to Science curriculum was used. Students were asked at the beginning of the course to complete a survey ranking their interest in each of these 26 disciplines. Students were asked on the last day of class to reassess their ranking and to evaluate the effect that the Segues had on their outlook regarding these disciplines. The purpose of the surveys was to help evaluate the progress of the Segues project, and to gauge the effectiveness of the individual Segues.

After three years of implementation of the Segues, involving 426 students, the botany segue proved to be the most popular with the students and the most successful. Success of each Segue was calculated based on the increase, or decrease, of each student’s interest in a particular discipline over the course of the semester. In this case, more students increased their interest in botany than any of the other 26 disciplines, based on the Segue curriculum. Student response to the innovative teaching and learning methods implemented in the Segues project remained positive throughout the duration of the project. In the end, all of the scientific disciplines that were part of the Segues saw improvements in student interest. What is important is that the Segues with the greatest level of taste/smell sensory content consistently ranked the highest while those that involved hands-on experiments that emphasized other senses (vision, hearing) were much less accepted.
CONCLUSION

Educators and Learners

Almost any idea in our modern society can be learned through books or on the Internet. It is easy to go beyond learning the basics and even get to understand a subject on a truly substantial level. However, some concepts cannot be understood except through sensory perceptions. We have seen that some cider makers can perceive an entire orchard and the flavors contained within through sensory observation and correlation, such as taste. We have also seen that students, when left to their own devices, are able to fall back on their senses to classify the plants in their world.

Human beings have been tasting and perceiving their environment for a very long time. We, as a species, were able to classify our surroundings based on our sensory perceptions long before there were books to teach us about our environments. Perhaps we need to reintegrate sensory experiences into our educational methods and return to what our brains are well equipped to handle; sensory perceptions. By involving the senses of taste, smell and touch in the botany classroom we hope to expand the instructional resources, better engage the students, and teach things that go beyond what can be learned from a textbook.

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