

Without these usual helps there were three points which I decided when I began in September to teach botany from the text-book. First, I changed the order of the book; second, I required out-door individual work; third, I combined the drawing lessons with botany. I began the work with the leaves, their parts, structure and variety. The autumn tints were lending wonderful beauty and glory to the leaves, and it seemed the right time to study and collect them. Examples of the different shapes, apex, margin, base, etc., were required day after day from each pupil.

I found this a success, for it took them from the text-book to Nature, and thus in the very beginning made their work an enjoyment. It also taught them far more than memorizing text-book definitions, and satisfied them that Nature makes no two leaves alike, but gives up an endless variety of shape. (These sheets show the work of one of the class.)

Hand in hand with this out-door work came the *sketching* of the leaves. To me botany and drawing are inseparable—the value of their being taught together cannot be too strongly urged. In my own experience I have not seen half as good results follow from book measuring and copying as I have from taking the simple objects from Nature and sketching them. In Nature-drawing two good results follow—new knowledge is gained and accurate observation is tested and trained. Many in my class did not notice at first that in a palmately netted veined leaf like the maple the veins started from a common centre, where the footstalk joins the blade. Description written below.

The arrangement of the *leaf* in the *bud* was next studied and sketched, and many were the delightful surprises found on opening the buds of the lilac. Some of the class found, what they had never noticed before, that the flower cluster was wrapped within the leaves and these surrounded with scales, and all would be ready to burst into new life in the spring. To take the buds of different trees and notice their covering and protection forms an interesting study; as, for instance, the horse chestnut, with its sticky outside covering and the soft, downy winter clothing within.

The *seeds* were next in order, because so many found in the fall could not be found at any other time in the year. Encourage the pupils to bring examples, and especially any kinds which interest them. Show the use of the silky tuft on many of the seeds of the composite—how these “sky rovers” are carried far from their own flower and settle into some ground where they, in many cases, have to battle with numerous other seeds for their life, which afterwards become a nuisance to the farmer. Only a few examples of the

seed were sketched, those which served to illustrate the fleshy and dry fruits, the berry, pome and bean. With the heart opened and the intelligence quickened the pupils will next turn to the study of *germination*, and find it one of the most pleasurable in the book. With their previous knowledge they may quickly go on to appreciate the details of a deeper study. In no way can the life of all growth be as well understood as to watch it. A box of seedlings with their slow, yet apparent growth, may become a daily marvel. The common bean reveals such clever contrivances that it can be used again for study. A glass can show each seed in plain sight, and the process of swelling, sprouting and embryo developing gives a better idea of the growth of seedlings than pages of book description. I used in germination work a tabulated blackboard outline like the following. These outlines hold the attention of the class, and classify to them what oftentimes seems vague and separated. Have ready for study bean pods, dry and soaked beans and seedlings, both for study and sketching:

I. BEAN POD (the natural cradle)—

1. Hilum or scar.

II. DRY BEAN—

1. Color, shape, size, structure.
2. Micropyle.
3. Comparison with other seeds.

III. SOAKED BEAN—

1. Condition of skin (ruffled, increases in size before body does).
 - 1'. Translucent.
 - 2'. Venation (veins run to scar, channel by which mother plant sent food to seed).
 - 3'. Two coats (on one shows toughness, to hold together the parts to protect embryo).
2. Micropyle (passage of pollen tube through skin to bring life to seed).
3. Cotyledons.
 - 1'. Size, purpose.
4. Embryo.
 - 1'. Parts radicle, plumule consisting of two leaves with veining, outer wrapped around smaller.

IV. SEEDLING—

1. First appearance (backs out of ground).
 - 1'. Radicle (pushing into earth).
 - 2'. Cotyledons.
 - 1". Change of color (from white to green).
 - 2". Position (hold themselves over embryo till it is out of ground, then slowly separate so sun can reach plumule).

Then try original work, anything *outside* the book interests and attracts.

V. EXPERIMENTS WITH SEEDLINGS—

1. In sawdust (flourishes till food of cotyledons is exhausted then “shrink”).
2. In sand-siftings mixed with gravel (same).
3. Rich earth (flourishes with roots).
4. Cut off cotyledons, die.
5. Lessons learned.
 - 1'. Cotyledons—warm house for embryo, store-house of food.
 - 2'. Soil provides food.