Developing Social Awareness in Elementary Schools Through Experiments with Plants

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John F. Chapin
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I recommend this thesis for acceptance by the Honors Program of Ball State University for graduation with honors.

C. Warren Vandegrift
Thesis Adviser

Department of _______________________

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Introduction and Rationale

With a growing awareness, elementary teachers are realizing that they must offer learning experiences dealing with human sociology to children at an impressionable level in an effort to better the society in which we live. This is especially true in light of the many problems our society faces today—race relations, pollution of the environment, war, drugs, etc.

It is my belief that very significant concepts can be taught in very simple ways to even the youngest child through the use of plants. We all know how easy it is for children to relate to other living things around them, plant and animal. They have an appreciation for Nature and her subtle interactions that we usually fail to incorporate into their learning experiences in school, except for the potted plants in the windows or an occasional "nature hike". But, with a correlation of scientific experiments with plants and social concepts, great success can result in the classroom, the effects of which will be felt, hopefully, as the child matures and is able to relate the concepts to his everyday life and actions.

I have prepared a series of experiments or investigations to use and supplement other experiences the teacher might think of. Each may be adapted to any level although some may be better with certain age groups. Each procedure is followed by suggested questions for discussion as well as additional activities and possible vocabulary words to introduce. The materials used are easy to obtain and inexpensive. It is hoped that these activities will help produce more enlightened and creative citizens.

John F. Chapin
Ball State University
1. Seed Structure

**Purpose:** To examine various seeds of common plants to discover how they prepare the young plant for living after germination.

**Application:** The results of this investigation can be used to help children be aware of their own physical endowments and their purposes. In the upper grades, a unit on human development could easily stem from such an activity.

**Materials:** Seeds (large types preferred—lima beans, castor beans, peanuts, etc. although castor beans are poisonous and must be handled with care)

Glasses or bowls of water

**Procedure:** Have the children first soak the seeds in water for 24 hours. They will be amazed to see how much they swell in such short time. Have them find the little hole in the concave side of the seeds and explain that that is where the water is absorbed.

The next day, tell the class to peel the protective covering off of the seed to expose the inside (each child should have his own seed, with extras ready in case they are needed). Bean and peanut seeds have two halves (cotyledons) which can be separated to see the inside parts. They should be able to see the following:

- plumule (leaves)
- radicle (root)
- cotyledons (food)
Discussion Questions for #1  

Seed Structure

**Biological:**

What changes occurred to the seed while soaking in the water?

What part of the little plant in the seed would be the stem?

How does the covering serve the seed? Does it change after soaking in the water?

Why are the cotyledons so large compared to the plant?

**Sociological:**

How prepared are human babies for life when they are born?

Is there anything like the cotyledons in a baby?

Using pictures of human embryos ask the following:

What do arms and legs look like at the very start of their development?

How soon do the facial features develop?

What serves as the food supply of the human embryo?

**Other Activities:**

Compare seeds of different plants. You may have to use a microscope to see the parts of some. Compare dicot and monocot seeds.

Investigate sources of seeds: fruits, pine cones, etc.

**Vocabulary:**

<table>
<thead>
<tr>
<th>Word</th>
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<tr>
<td>seed</td>
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<tr>
<td>plumule</td>
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<tr>
<td>radicle</td>
<td></td>
</tr>
<tr>
<td>cotyledon</td>
<td></td>
</tr>
<tr>
<td>micropyle</td>
<td>(water hole)</td>
</tr>
<tr>
<td>embryo</td>
<td></td>
</tr>
<tr>
<td>monocot</td>
<td>(monocotyledonous)</td>
</tr>
<tr>
<td>dicot</td>
<td>(dicotyledonous)</td>
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2. Germination

**Purpose:** To examine young seedlings to see what changes have occurred in the seed upon germination and initial growth.

**Application:** This procedure is actually an extension of #1 in that it fulfills the investigation of seeds. It can also be used in conjunction with #4. Studies of physical development could be lengthened with these experiences.

**Materials:** Seeds (bean, corn, or peanut)
- Jars (quart size best)
- Paper towels

**Procedure:** Roll the paper towels and insert in the jars.
- Dampen the towels liberally.
- Insert the seeds between the towels and the glass side of the jars (about 8 to a jar).
- Keep moist.

After germination, have the students examine the growing seedling for the same parts they found in the seeds. Have them make drawings of the seedlings and the parts. Have them explain how they have changed. Predict what will happen to the parts now (see questions).

![Corn Seedling Diagram]
Discussion Questions for #2 Germination

Biological:
What part of the embryo plant was the first to emerge?
What changes occurred in the parts after germination?
What will eventually happen to the cotyledons?
If a seed was "upside-down" in the jar, did the radicle still go down and the plumule up?
How are the bean and the corn seedlings different? Alike?
How soon do the plumules get green?

Sociological:
What changes take place in a baby's appearance after birth?
What parts of the human embryo are no longer needed after birth?
How long is the baby dependent on outside sources for food compared to the young plant?

Other Activities:
After a few days growth, turn the jars upside-down and see what happens.
Plant some more seeds in a flat and examine them more closely after germination.
Plant seeds that have not been soaked for 24 hours and some that have. Compare times they take to germinate.

Vocabulary: secondary roots
root hairs
germination
chlorophyll
hypocotyl (stem)
3. Requirements for Growth

Purpose: To demonstrate the effects of temperature, light, and water on the growth of plants.

Application: By demonstrating the need for plants to have certain ideal growing conditions for optimum development, it is hoped that the students will become aware of their own human needs. They will see that there are basic needs of all human beings and that they are important for the best health and development.

Materials: Seeds (corn or bean best)
Soil (see appendix for mixture)
Pots or flats ("")
Water
Source of cool temperature (refrigerator or outside shelf if winter)

Procedure: Plant 6 pots of seeds (identical pots and amounts)
Water all except one (1).
Place one in a cool place for the first 3 days.
Place another in a dark closet.
Leave others in a light, warm spot (including the dry pot which is never watered).
Water all the pots regularly—except the dry one.
After 2 weeks, compare the growth of the seeds.

Note: It is best to label all pots used in these experiments to avoid confusion.
Discussion Questions for #3  Requirements for Growth

**Biological:**
What was the effect of cold temperatures on the seeds? No water? Darkness? What was the least harmful temporarily?

Which condition could be remedied?
What would be the effects of different temperatures?

**Sociological:**
What are some determining factors during human pregnancy?
What effect do they have on the embryo and the mother?
Which can be corrected?
What are marriage blood tests for?
What are the immediate requirements for the newborn baby?
Are babies immune to disease?

**Vocabulary:**
control (in experiments)
growing season
body needs
premature baby
formula (feeding)
German Measles
Rh factor
4. Development

**Purpose:** To demonstrate the changes a plant undergoes while maturing and reproducing.

**Application:** Obviously, this unit is very well suited to introduce the "hard-to-get-started" lessons on reproduction or the highly debated "sex education". It should be used in addition to other studies of animal behavior as well. But, this lesson is also helpful in the continuing study of human development.

**Materials:** Bean seeds

- Pots
- Soil

**Procedure:** Although this lesson can be prepared by the students themselves, I think that it would be much more effective if the teacher were to prepare the materials and then present them to the class.

The preparation involves planting successive pots of beans so that the development of the plants can be seen collectively. A pot is planted every two weeks until you have at least 4 pots. When the last pot's seeds have germinated and are breaking at the surface, present all the pots together. The first pot's plants should be in bloom and possibly even have young beans. Thus the whole range of development—germination through reproduction—is illustrated. (see photograph)

Discussion is taken from here.
Discussion Questions for #4 Development

Biological:
What functions do the cotyledons perform for the plant?
Does growth seem to go on evenly throughout each stem and root? If not, where does most growth occur?
Are growth patterns the same in all plants? How could you determine this?
What happens to the cotyledons?
How have the roots changed? When do the flowers develop?

Sociological:
What are the changes the human being goes through during the first 10 years of life? (much discussion)
What changes happen at puberty? (guided discussion)
What can block human development? What can we prevent?

Other Activities:
Keep measurements of growth rates of the parts of a seedlings daily?
Expose trays of seedlings to various obstacles (cold, heat, drought, disease, etc.) to emphasize developmental sequences.
Using light filters, investigate the effects of various types of light on development.
Examine flowers for identification of the parts used in reproduction. Use larger flowers for easier initial research. Apply to bean blossoms.
Examine young bean pods at various stages of development.

Vocabulary: Terms for human reproduction (follicle, egg, etc.) flower parts (pistil, stamens, etc.)
5. Conditions Affecting Growth I

**Purpose:** To demonstrate that space is a factor in the quality of plant growth.

**Application:** This unit will vividly illustrate the effects of overcrowding on plant populations. It can readily be applied to a study of human overpopulation and crowded living conditions (such as slums).

**Materials:** Radish seeds
- Pots (2)
- Soil

**Procedure:** In one pot, plant a few radish seeds (not more than a dozen) well spaced so that they have plenty of room to grow.

In the other pot, plant as many seeds as possible without layering so that they will be very crowded upon germination.

Water each the same and expose to same conditions for optimum growth.

Although the results will be noticeable a week after germination, wait until the radishes have had time to mature (at least 4 weeks) before uprooting specimens of each for comparison. The differences will be much more apparent.

Compare leaf size, root system size, and development of the radish (edible part) itself.

Also, note the differences in appearances of the two total populations. (see photographs)

**Note:** This can also be done well with grass seeds (or both).
Discussion Questions for #5  Conditions Affecting Growth I

Biological:

How soon are differences in development noticeable? What are the most obvious?

What are the differences in leaf size? Root spread?

What is the general condition of the edible part in each pot?

Are the more crowded radishes more susceptible to disease because of their condition and general weakness?

If the crowded seedlings were thinned, would they recover and gain in size and strength?

What is the general appearance of the crowded pot compared to the other?

Sociological:

What are the possible results of overpopulation?

How crowded could conditions become before we would weaken as a nation? As an individual?

What are conditions like in slums and ghettos?

What are the effects of too many people in India?

What are some solutions to the population problem?

Additional Activities:

Thin a crowded pot to see if there would be any changes.

Plant various amounts of seeds to see gradations of crowding.

Vocabulary: population explosion zoning
"the pill" housing development
famine family planning
mass education
6. Conditions Affecting Growth II

**Purpose:** To illustrate the effects of hormones on the development of plants.

**Application:** By demonstrating the use of plant hormones in aiding plant growth, it is hoped that the children will see the importance of medicine and other physical treatments on human beings.

**Materials:**

**Part I**
- Plants (coleus, ivy, or some common houseplant)
- Vermiculite (see appendix)
- Pots
- Water
- Rooting hormone (see appendix)

**Part II**
- Tomato seedlings (potted)
- Gibberellic Acid (see appendix)

**Procedure:**

**Part I**
- Take cuttings (slips) of the plants available.
- Put some of the cuttings in a glass of water to develop roots the "old-fashioned" way.
- Put some of the others in damp vermiculite.
- Dip the rest in the rooting hormone and put in vermiculite.
- Wait a few weeks, then compare average root development of each group.

**Part II**
- Choose seedlings as identical as possible in size and appearance.
- Treat one of the seedling (or one group) with gibberellic solution daily (according to directions) for two weeks. Results will be obvious shortly.
Discussion Questions for #6  Conditions Affecting Growth II

Biological:
Which cuttings had the poorest root development? (average)
Which had the best root development? (average)
What is in the rooting hormone that makes it effective?
Where do the producers get the hormone?
What other uses could there be for this hormone?

What were the differences in the tomato seedlings?
Where is gibberellic acid derived?
What are its possible commercial uses?

Sociological:
How do humans use hormones?
What possible hormonal imbalances could exist in our bodies? What are their effects?
How can hormones cause imbalance problems?
How can hormones cure imbalances?
What other similar substances or chemicals does man employ to help physical and mental disorders?

Additional Activities:
Use the hormones and acid in varying degrees to see if one can have a type of controlled growth of intermediate stages.

Vocabulary:  hormone  dosage
1- hormone treated (vermiculite)
2- no hormone (    )
3- no hormone (water)
7. Conditions Affecting Growth III

Purpose: To demonstrate the effect of soil conditions on the development of plant populations.

Application: Since the soil is one of the most important factors in determining the quality of plant life, it is possible to apply this experiment to the quality of our environment.

Materials: Radish and grass seeds

Pots (6) (6" is a good size)
Topsoil
Subsoil (clay)
Sand

Procedure: Fill 2 pots with topsoil, 2 with subsoil, and 2 with sand.

Plant the radish seeds in one of each type of soil.

Be sure to plant an equal amount in each pot (not too many).

Plant the grass seeds in one of each type of soil.

Water all of the pots with equal amounts and place in a sunny window.

Treat all of the pots exactly alike. Do not give more water to the sand pots even though it runs right through.

Compare growth in the pots at the end of 3 or 4 weeks.

(see photographs)
Discussion Questions for #7  **Conditions Affecting Growth III**

**Biological:**
Which soil type produced the better plant populations? Why?
Which soil type produced the worst plant populations? Why?
What factors regarding nutrients and water make topsoil the best?
What main factor about sand and water make it poor for plants?
What main factor about subsoil (clay) make it poor for plants?
How could you raise good plants in sand and/or clay? What would you add or use on the soil or plants?

**Sociological:**
What type of environment is best for human populations?
What type of environment could you compare the sand or subsoil soils to?
What can we do to improve slums?
Do we have to completely remove slum areas or is it possible to renovate them with the help of the residents?
What effects could slums have on the development of people?
What happens to people once they live in a better environment? Do they change?

**Additional Activities:**
Try to transplant some of the radish seedlings from sand or clay to topsoil and see if they get healthier.

**Vocabulary:**  
- slum  
- urban renewal  
- welfare  
- relocation  
- unemployment  
- conditioning
8. Plant Evolution

**Purpose:** To introduce representatives of each order of plants to the students so that they might compare structure specialization of tissues.

**Application:** After investigating the examples of evolution in plants, it will be very easy to glide into a discussion of human evolution, based on the principles already evident in plant evolution (structure and specialization of tissues). This will be more applicable to the upper grades, but can be simplified for primary students.

**Materials:** Mushrooms, mold, yeast and other fungi
- Algae
- Moss
- Liverworts
- Ferns
- Pine (or other gymnosperms)
- Flowers (or some angiosperm)

**Procedure:** The main idea is to introduce a member of the plant kingdom, starting with the "lowest". Tell about its characteristics, let the class examine them, etc. It will take about 2 weeks to go all the way through the kingdom.

It may be a good idea for the students to keep botany notebooks for drawings and observations.

A good summary of this study could be a field trip to see how many types can be found in the wild.
Discussion Questions For #8  Plant Evolution

Biological:
Questions of the following type should be asked as each plant is studied:

What color is this plant?
What does this indicate?
How small or large do these plants get? What limits their growth?
How do these plants get their food?
Does this plant have stems? Roots? Leaves? If not, what do they use in place of them?
Of what use are these plants to man?
How does this plant differ from previous plants we have studied?

Sociological:
Do animals have a similar evolution?
How do animals differ?
How do we group animals?
Do we group man with any other animals?
What traces of animal-type traits do we still have?
Physical and mental.

How does the study of so called "lower animals" help man to live better?

Additional Activities:
Go through animal classifications like the plant.

Bring in strange plants and try to classify them into general groups already studied.

Vocabulary: -many technical terms relating to scientific classification and evolution
9. Individual Differences

Purpose: To show that there are individual differences in populations of plants.

Application: Obviously, show that there are individual differences in human populations as well. Each child should see that such differences are natural and to be expected, as well as appreciated for the variety and interest they bring to everyday living.

Materials: Bean seeds
           Flat
           Soil

Procedure: Plant the seeds in a flat of soil. Space them evenly for maximum development.

           Water.

           About a week after germination, uproot those that show different characteristics (short, tall, weak, strong, few leaves, many leaves, etc.)

           Discuss how this could happen in a population of plants that were all treated the same.

Supplemental Activities: Obtain plant curiosities such as the sensitive plant (Mimosa—see photograph), Venus fly-trap, pitcher plants, velvet plant, etc. Discuss how each of these plants is unique and possibly why. How do they add to our enjoyment and appreciation of the plant world?

           Obtain seed of albino corn (from supply houses) to illustrate the phenomena of mutations. (see photograph) This is, of course, a more drastic form of individual difference.
Discussion Questions for #9  Individual Differences

**Biological:**
What general differences do you find among the seedlings?
What differences do you find in height?
What differences do you find in number of developed leaves?
What differences do you find in root system development?
What similarities do you find in all of the seedlings?
What accounts for the differences?

**Sociological:**
What differences can occur in individual human beings?
What basic traits do all persons exhibit?
How important are the differences between races?
What are some commonly referred to traits of different races?
What are some factual differences?
How can mental differences be important?
How can physical and mental differences be overcome?

**Additional Activities:**
Described on previous page.

**Vocabulary:** inheritance
names of races (Caucasoid, Negroid, etc.)
individuality
mutations
albinism

**Note:** it may be easier to use vermiculite instead of soil for #9
10. Terrariums- Community of Plants

**Purpose:** To demonstrate the principle of a self-contained community of plants.

**Application:** Applying this lesson to human populations is easy and very effective. The jar of plants, self-contained, easily becomes our planet (especially with the aid of recent space photographs). The necessity of taking the responsibility to care for our own little "jar" of life, the Earth, becomes all the more apparent. A dramatic lesson can be taught with Part II, dealing with pollution.

**Materials:** Large jar (gallon is best)
- Small plants (common house plants)
- Bits of charcoal
- Sand
- Soil

**Procedure:** To make your terrarium:
- Clean the jar thoroughly and rinse.
- Spread a thin layer of sand on the bottom.
- Sprinkle some bits of charcoal on the sand (keeps soil fresh).
- Spread soil on the sand.
- Plant the plants, not too crowded.
- Water and place in indirect light.

(If there is too much water, you will not be able to see inside. Merely open the jar for a few hours and then close again).

**Part II**
- Make another terrarium, identical as much as possible.
- Pollute one of them daily (use car exhaust, cigarette smoke, etc.).
- Observe the results after 1 week.
Discussion Questions for #10 **Community of Plants**

**Biological:**
How does the self-contained terrarium use its air?
How does it use the water?
What eventually will happen if there is unlimited growth?
Will there be any chance of some plants taking over?

What happens to the plant community when it is polluted with either bad water or bad air?
Can polluted conditions be remedied at first? Is there a "point of no return"?

**Sociological:**
How is our earth like a terrarium?
What is the water cycle?
How does man disrupt the ways of nature?
What are the reasons for his actions?
What could be the end results?
How can we take care of our self-contained Earth?
Can all of earth's people live together?
What could be the results of unlimited growth?
Just how fragile is the Earth?

**Additional Activities:**
Try to save a polluted terrarium by airing out.
Plant too many plants in another and observe the results.

**Vocabulary:**
- environment cycles (water, nitrogen, etc.)
- recycle (i.e. wastes)
- desalination
- pollution (air, water, noise)
Appendix of Materials and Terms
Appendix of Materials and Terms: (red number indicates number in photograph)

**flat** (1): A flat is usually a wooden box approximately 16"X12" used to plant a large amount of seeds. Can be easily made or purchased at a local greenhouse.

**gibberellic acid**: This is a substance produced by a fungus that promotes plant growth (fungus is "Gibberella fujikuroi"). It can be purchased from science supply houses.

**markers** (2): Markers are wooden or plastic sticks that should be used to prevent confusion or possible mistakes in experiments. Tongue depressers or popsicle sticks are good markers.

**plants** (8): The plants used in these experiments are easily obtainable from local florists or dime stores. It is best to use soft-stemmed plants for cuttings and terrariums. Tomato seedlings can be purchased or raised from seed.

**pots** (3): The best pots for any plant are common clay pots. Although they are not the most beautiful, they are healthy for the plants as they allow for good drainage and air circulation as they are porous. They are also inexpensive. Clay trays can be bought to place underneath the pots. Pots come in all sizes from 1½" to 6" on up.

**rooting hormone**: Rooting hormone is available commercially in most florists' shops or greenhouses. Most common is "Root-tone" (trademarked). It comes in powered form, is inexpensive and easy to use.

**seeds** (4): Seeds are easily obtainable in garden stores in the spring. However, one can save beans and corn in the fall for winter use. Seeds can also be purchased from science supply houses year round. Some are chemically treated and color coated as an indication that they are not for human consumption.

**soil** (5): The best potting mixture is as follows: 2 parts topsoil, 1 part peat, and 1 part vermiculite.

**vermiculite** (6): Vermiculite is actually expanded mica, a mineral, that is used as a soil loosener and has excellent water holding capacities. Thus, it can be used to start seeds when a clean, sterile medium is needed.

**watering** (7): Although most watering can be done with a jar of water, some delicate seedlings might need a special sprayer to avoid injury. These can be found in garden stores and are relatively inexpensive.