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TEACHING MEAP ECOLOGY OBJECTIVES
MORE PRODUCTIVELY IN THE MIDDLE
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TEACHING MEAP ECOLOGY OBJECTIVES MORE PRODUCTIVELY IN THE MIDDLE SCHOOL CLASSROOM

By

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ABSTRACT

By

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Ionia Middle School's students' Michigan Educational Assessment Program test scores have been low, compared to the state average, for the last five years. Their lowest section on the MEAP test has been the ecology, which contains more objectives covered on the MEAP test than any other section. The science teachers needed to teach the ecology objectives to the students so that the students would retain the information. Therefore, I developed a series of experiments based on the ecotube that has improved students' understanding and retention of and retaining the important objectives of ecology.

Teaching the ecology objectives using the ecotubes was very efficient because the students could remember more of the objectives than if the objectives were taught the traditional way. The reason for this was that using the ecotube as a tool reinforced the ecology objectives using the three sensory modalities: visual, auditory and kinesthetic.

In 1995, the ecology test was given to the students after they were taught using the traditional methods of teaching ecology. In 1996 and 1997, the same ecology test was given to the same age students taught using the ecotube experiments.

The results were remarkable. The students who took the ecology final exam in 1996 and 1997 had dramatically increased scores. The students' MEAP scores were also higher than those of 1995. Not only were the student's scores higher, they also seemed to enjoy the hands-on style of learning that ecology in a bottle provided.

This thesis is dedicated to my wife Diane and
my children Carli, and Sierra. Also I would like to thank Jesus.
With Him nothing is impossible.

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INTRODUCTION

When the science teachers at my middle school met in the fall of 1995, we were faced with the unsurprising news that our science MEAP scores were below the state average. The ecology section of the MEAP stood out because the results were extremely poor. Fifty percent of students did not score in the proficient range. These scores coincided with low ecology final exam grades. I also saw that there were thirteen ecological MEAP objectives throughout the MEAP test. With so many objectives and so little time to teach, one can understand why the students might forget some information. We needed to find a way to effectively teach many objectives in a short period of time. The science teachers got together and brain-stormed ways to do this. We knew that our ecology unit had the same objectives as the State of Michigan, because in 1992, we aligned our ecology unit with the state objectives in ecology (See "MEAP Ecology Objectives", Appendix A). We needed a tool to help the students understand the ecology objectives better. I knew in order for the students to understand the objectives better, they needed to personalize the objectives, have more hands-on activities, and have their individual learning styles addressed. I decided that using the ecotube as a basic tool to teach the ecology objectives would address these issues.

The idea of using the ecotube to teach the ecology objectives sprang from a science education conference entitled "Organization of Living Things and Ecosystems." It was a conference that showed how to teach ecology using-two liter plastic pop bottles (See "Organization of Living Things and Ecosystems", Appendix B). The bottles were simply arranged so that the one on top held land organisms. The bottom pop bottle was to be the aquatic ecosystem with fish, snails, *Elodea*, and algae. The ecosystems once set up were to be almost self-sustaining. The ecotube is really an interactive tool for teaching the ecology objectives, since students keep records and check the conditions of their ecosystem. They also engage in activities with and without the ecotube. The ecotube is the basis for minds-on activities and hands-on labs dealing with ecology which should guide the students to a more personal understanding of ecology. This personal understanding is what teachers want from their students. Randolf Tobias' research shows that, "Showing relationships between science and the children's everyday lives' is one of the keys to successful and effective instruction (1992)." The ecotube also is a means to teach ecology by addressing the learning styles of individual students. In order to reach every student, the teacher must teach using all three sensory modalities or learning styles: auditory, visual and kinesthetic. If you want to give every student an opportunity to learn, you must teach with their individual learning styles in mind.

"A school staff should consider the present level of instruction and investigate methods by which teachers can manipulate the instructional methods so that the teaching strategies and techniques are compatible with the learning styles of the students." (Carroll, 1963)

Instruction with the ecotube is one such instructional method used to teach the ecology objectives with all three learning styles in mind. For example, a simple task, such as learning to spell a new word, is approached differently depending on learning styles. One student might be able to learn better if he or she sees a word on paper, another might have to say the word and a third might have to do an experiment relating to the word before he or she understands it thoroughly. Teaching to every student's learning style is one of the hardest jobs a teacher has to perform. While it might be one of the most challenging jobs, it is also one of the most important.

How long does it take for a person to remember how to spell a word? It may be easier for a person to hear the word in order to remember it. Do you have to say the information aloud in order for you to learn it better? Do you put facts and figures into a song or a rap in order to memorize the information better? If you do these things to remember information, you are probably an auditory learner. Cynthia Tobias (1996), says that an auditory learner learns by listening to verbal instructions and remembers information by forming the sounds of words. If you are a strong auditory learner, it does not mean you need to hear someone say something to remember it. It does mean, in most cases, that you need to hear yourself say it in order for you to remember it better.

Another person might be able to recall the word better when he or she sees it on paper. Do you use brightly colored folders or notebooks to stay organized? Are you accused of daydreaming or being lost in thought? If so, then you might be a visual learner. Visual learners use strong visual associations when remembering information. They associate pictures with words or concepts (C.Tobias, 1996). Whenever the teacher explains something, these types of students must draw a chart or a picture to help him or herself understand. Students who learn this way may need brightly colored flash cards or worksheets. Drawing a quick picture of what is being taught helps some visual learners comprehend the situation.

Still another person might be able to remember the word better if he or she uses it in a sentence. Have you ever been told to "sit still", "put your feet on the floor", or that you were "fidgety"? Do you have to have some type of action in order for you to learn? If so, you are probably a kinesthetic learner. These learners are very energetic and usually cannot sit still for ten minutes.The "learning" action can be anything from dissection of a cat to just walking around while trying to memorize something. Cynthia Tobias wrote about a girl named Anne. Her mother would tell her to stay in her room or the basement until her homework was completed. This restless and resourceful learner did not like to sit still when she worked, so she devised a way to learn. Anne had steps in her basement and her mother noticed her walking up and down these steps while she was studying. For spelling, each step was a letter or a word. For history, each step was a fact or date. For geography, each step was a location or place. Anne could remember the information better and her grades showed steady improvement. Anne found a profession to fit her kinesthetic learning style, that of a physical education teacher. To teach to the kinesthetic learner, the teacher should have demonstrations and labs on the objective being taught. Associating information and facts to a body movement, allowing the student to walk around and do something with the information being taught will also help the kinesthetic student to understand the objectives.

Every person learns and remembers information differently. If teachers keep the three learning styles in mind, all the students in the classroom will have a better chance of reaching the objectives. Lawrence Lezotte indicated how important it is to use sensory modalities when teaching when he wrote,

"The teachers have to carefully plan the lesson and should use sensory modalities to help the students to connect and retain the content being taught" (Lezotte 1992).

Since teachers teach from twenty to thirty students in a class, he or she should teach each objective with all three learning styles in mind.

"It is essential that teachers be trained to assess individual children's learning styles so they can adequately plan instruction that uses the techniques and strategies to facilitate learning success." (Robinson, 1990).

Having the teacher teach with the three sensory modalities in mind is not sufficient to optimally use learning styles as a basis of instruction. The students must know what type of learners they are. Cynthia Tobias (1996) in, *The Way They Learn*, talks about a class she taught that always did poorly when they took a semester test on eighty-four difficult vocabulary words. She decided to have the students review differently for the test than they had before. The students reluctantly agreed. She explained the three styles of learning to the students and had them fill out a checklist (See Modality Checklist, Appendix C) to see what type of learner they were. For the next three days, the students would devote time to studying the words using their own learning style. Out of twenty-nine "mediocre" students, twenty-six of them did not miss one single item on the test, and no one missed more than five. The most impressive part is that the students remembered the terms for over a year. One student went into the Navy after graduation and returned two years later. He asked the teacher for the same test, and he got eighty-two out of eighty-four correct. This anecdote stresses that the students should know which sensory modality works best for them when learning.

Addressing students' learning styles can be readily done in science classes. The ecotube will provide opportunities to tap into each student's learning style. The ecotube is a basis for lectures as one means of auditory learning. There is a problem with using lectures because they can be rather boring. They may not allow active, energetic bodies to relate or personalize any of the objectives. When the ecotube is used as a visual tool during lectures, it is easier for the students to pay attention longer. The teacher can use the ecotube to illustrate information and the students have a visual representation with the auditory feedback to help them personalize the idea. "The most effective training combines lectures, modeling, practice, and coaching" (Herbert Walberg

1990). When the teacher uses the ecotube to teach ecology, this is what he or she is doing. The teacher does not just lecture but also utilizes the ecotube as a model. An example of this occurs when the teacher lectures on food webs and the students are instructed to find a food web in their ecotubes. Use of the ecotube leads to hands-on and minds-on activities which appeal to visual and kinesthetic learners. Minds-on activities range from determining the abiotic factors in their ecotube to predicting what would happen if certain conditions were changed. These activities address visual and kinesthetic learning styles and help to reach as many students as possible.

Working with the ecotube every day allows the visual and kinesthetic learners to understand and conceptualize objectives for that day. Using hands-on activities is always a great way to get students to understand the objective. Stephen Foster (1996) wrote, "we learn to do by doing, by instruction in or by images of doing and by observing others doing". This is the kinesthetic style of learning, where students learn by doing something physical which deals with each objective. The ecotube is something the student made, so they will immediately personalize it. Doing numerous labs using the ecotube will allow the student to get to know how each organism is connected in the "mini ecology" ecotube. The kinesthetic modality is addressed by checking the ecotube to see what abiotic and biotic factors have changed from day to day. Numerous checks will allow the student to become familiar with their ecotube and how each organism is connected in the ecosystem within the ecotube. They will regularly do activities and checks on their ecotube and explain what is happening.

Using hands-on activities in the science classroom is an important key to getting students to be successful in science. Donna Uchida (1996) did some research on what teachers need to do to prepare students for the 21 st Century. She stated,

"Active learning should be increased, with more student involvement with hands-on projects, Socratic questioning, cooperative learning, manipulative, and experiments."

Using the ecotube to teach ecology uses all these methods.

Incorporating the three learning styles and ecotubes into my ecology unit seemed to be the most effective way to improve our original ecology unit. The original ecology unit was taught using the traditional method of teaching out of the textbook. Teaching using the ecotube is significantly different from the traditional method of teaching. The traditional method can be monotonous and boring. This style of teaching does not appeal to the majority of students. Patricia Phelan discusses this in her research which deals with improving school environments. She states,

"Perhaps the most resounding theme in discussions with students about pedagogy is that they want to learn from teachers, rather than simply read textbooks...the teachers who depend primarily on the lecture method of instruction risk alienating many students." (Phelen, 1992)

Using the ecotube gets away from the tiresome traditional method of teaching by using a variety of learning styles. Phelen also states, "When a variety of teaching methods are used, students report a high level of interest." This interest then will contribute to understanding. This interest also stems from the students working on their ecotubes in groups. Phelen's research indicates that this group work is preferred by both high and low achieving students. Group work not only allows the student to learn the material more efficiently but allows the student to enjoy the material. We predicted that using the ecotube would be an outstanding way to teach ecology. It allows the teacher to reach all the students by teaching incorporating all the learning styles. Since it is a long term exercise, the students can learn at their own rate. The teacher can use the hands-on and minds-on activities to illustrate the ecology objectives so the students will enjoy learning. The ecotube also allows the students to personalize the objectives into a real life situation. Teaching using the ecotube can be summed up using Sue Teele's research on redesigning the educational system to enable all students to succeed. Teele stated,

"Our educational system should create learning environments that allow students to learn basic skills that apply to real-life situations, proceed at a rate that is achievable for them, make no unfair comparisons with the progress of others, ensure positive reinforcement, and provide curriculum, instruction, and assessment procedures that reflect the many different ways students learn and process information. " (Teele, 1996)

The students involved in this study were eighth-graders in Life Science classes. There were less than one percent of minority students who were Mexican Americans. In the school year beginning in 1994, I only taught one Life Science class. In 1995 and 1996, I taught two Life Science classes each year. I taught five Life Science classes in 1997. The 1994 and 1995 students (74 total) were taught ecology using the traditional methods of teaching, including lectures, filmstrips and some labs. The 1996 and 1997 students (171 total) were taught using the ecotubes as a basis for instruction in ecology. In the years 1994, 1995 and 1996, there were three Life Science teachers. In 1997, there were only two. The other Life Science teacher also taught using the ecotube in 1996 and 1997, but used a different evaluation tool. All data reported in this document are from my own classroom.

Each year, the same final ecology exam was given. It was the primary tool used to evaluate the effectiveness of using the ecotube in an ecology unit. The main difference between the years 1994 and 1997 would be using the ecotube, more labs, and more hands-on activities, that addressed the three sensory modalities.

IMPLEMENTATION OF UNIT

The students in the study were eighth grade Life Science students. It was a five week ecology unit taught in the first quarter of the school year, which provided some advantages. One advantage was that the students could go outside. This allowed us to do certain activities that could not be done in the confines of the science classroom. Having ecology taught in the first quarter allowed certain terms to be introduced such as organism, symbiotic, ecosystem, adaptations and food chains. This made teaching subsequent units such as the cell, the variety of life, evolution and genetics, easier. The study took place between the years 1994 and 1997, during which the students were taught based on the same ecology objectives (see MEAP Ecology Objectives, Appendix A). In 1994 and 1995, the students were taught using the traditional method of teaching. In 1996 and 1997, the students were taught using the ecotube. There were other teachers who taught Life Science during this period but only my data were used for this research, because the other teachers used a different evaluation tool. I used my ecology final exam as the primary means to measure the effectiveness of using ecotubes as a means to teach ecology in 1996 and 1997.

As a basis for instruction, the students in 1996 and 1997 took the ***sensory modality test*** (See Appendix C), so that they would know what kind of learner they were. Before starting the unit, the students were randomly placed into groups of four. The groups obtained three two-liter bottles and constructed the ecotube (See Organization of Living Things, Appendix B). The students made the land ecosystem first and then the aquatic ecosystem, putting in the required number of organisms (See Setting Up Land and Aquatic Ecosystems, Appendix D). After the ecotubes were constructed, I had half the students put aerators in their ecotubes; the other half put a portion of *Elodea* in each. Once the ecotubes were ready, the students were showed how to check their ecotube.

The students were required to check their ecotubes every Monday, Wednesday, and Friday, making ten terrestrial and ten aquatic checks. Once every student knew how to do all twenty checks, the students delegated assignments as to who should check certain components of the ecotube. Each job must be done by the same student to ensure accuracy in the data collection. Every day a check was made, the students recorded their data on the chart given to them (See Aquatic Ecosystem Chart, Appendix E). Once the students understood how to properly check their ecotubes, only five minutes of class time was required for each check. After the students grasped how to check and document changes the ecotube, they started the "guts" of the ecology unit. Figure 1 is an overview of the five week ecology unit. It lists the topics and shows corresponding activities with the objective being taught.

Figure 1 - Overview of the ecology unit

Topic	Meap Objective	Activities	Learning Style
1. Modality Test	N.A.	1 - The Test	N.A.
2. Succession	VI.A.2.C.	2 * The Drawing	K,V
3. Features of Life Life	VI.A.2.a. VI.A.	3 * What is a Living Thing - Biotic Factors in the Soil	K,V K,V,A
4. Population	VI.A.3.a.	4 * Population Density	K,A
5. Succession	VI.A.2.C.	5 * Water Saltiness and Brine Shrimp	K,V,A
		* Limiting Factors of Grass Germination	K,V
6. Organisms are Either	VI.B.1.C.	6 * Consumers and Producers	K,V,A
7. Feeding Relationships	VI.A.I.	7 * Competition Activity	K,V
		- Predator and Prey - Adaptations with Brine Shrimp	K,V,A K,V,A
8. Food Chains	VI.B.2.	8 * Owl Pellet	K,V
9. Cycles of Nature	VI.B.2.a.b.c.	9 - Demonstrating the Carbon Dioxide Cycle	K,V,A

Key :

* = Ecotube activity
\- = Non Ecotube activity
K = Kinesthetic
V = Visual
A = Auditory

The students ***drew a picture of*** their ecotubes the day after they constructed them (See Activity 1, Appendix F). They also drew their ecotube again after three weeks and also at the end of the unit. The students, using the drawings, stated what changed in their ecotubes. The students should have noticed a change in the land and aquatic ecosystems. The students then went back to their records and determined what caused certain things to die or survive. The students then discussed as a group what their ecotubes would look like in another three weeks. This showed the students what succession is, at least on a small scale.

The students then did an activity, called ***what is a living thing***, and deciphered the abiotic and biotic factors in their ecotubes (See Activity 1, What is a Living Thing, Appendix G). Before doing this lab, the students heard a lecture on the features of living things. After discussing the features of life, the students did a lab activity, not directly associated with the ecotube, to determine ***the biotic factors in the soil*** (See Biotic Factors in the Soil, Appendix H). This helped the students to understand that biotic factors do not have to be "big" or on a macro level.

The class then studied population density by viewing a "Bill Nye the Science Guy" video on this topic. We related these principles to their ecotubes. We found the population density of the room, and the students found the population density of their ecotube. We discussed how scientists determine the population of a species followed by an activity on ***Population density*** (See Activity 3, Appendix I). After reading an article on population density, its effects on competition, colonization and extinction, the students did an entertaining lab in which they studied ***water saltiness, brine shrimp and limiting factors***. (See Activity 4, Appendix J). Students needed to understand that "organisms" include plants so we then did a lab that dealt with ***limiting factors of grass germination***. (See Activity 5, Appendix K). We then discussed limiting factors in their ecotubes.

Once the students understood what populations and limiting factors were, we discussed communities and ecosystems, in conjunction with their ecotubes. This was followed by a filmstrip and a "Bill Nye the Science Guy" video on communities.

Next, students learned about producers and consumers. After the students had a good grasp of what these terms meant, they engaged in an activity related to ***consumers and producers*** (See Activity 6, Appendix L). This was followed by the ***competition activity***, which was based on varying amounts of grass growing in two separate containers (See Activity 7, Appendix M). Students then read an article on competition, which described the overlapping ranges of game animals and livestock and how they competed for food.

At the midpoint of our unit, we looked at changes in the ecotubes and related this to the student's readings. We discussed certain stresses the organisms were subjected to. Studying their written records, they should have seen a pattern that allowed them to make predictions of what their observations would be in three weeks. By this time, some of the fish in the ecotubes had had babies (from two to five). The students then observed what a lack of space would do to even the parents, which would eat their offspring if there is not enough space. The students got to see the cruelty of nature, first hand.

Feeding relationships was our next topic, including competition. Lecturing on competition with the ecotube in front of the students and relating the topic to it was a powerful means of learning for the students. The students could personalize and observe this competition in the form of food webs, food chains, competition and adaptations. We used the laser disk "Windows on Science" (1994) to show competition between different and similar species, such as a predator and prey relationship between a rabbit and a hawk. We discussed the adaptations of the rabbit and hawk. The students saw what was happening as the disk was playing, while being lectured on the information. We then went outside and played a game on competition called ***Predator and Prey*** (See Predator and Prey, Appendix N).

The students also had their ecotubes in front of them as we discussed certain feeding relationships in their ecotubes. This was reinforced by the students viewing a *Trials of Life* video, *Hunting and Escaping*. This was a graphic and vivid depiction of nature and the adaptations that predators and prey have. Students then studied the ***adaptations of brine shrimp*** (See Activity 9, Appendix 0), listing behavioral and structural adaptations. Using another *Trials of Life* episode, called *Living Together*, the students viewed different symbiotic relationships. With each of these films and filmstrips, the students completed worksheets that I developed to evaluate their understanding of the terms.

We next discussed food chains, food webs and energy pyramids in nature and in their ecotubes. They dissected ***owl pellets*** (See Activity 10, Appendix P), putting the bones they found into groups (rodent, shrew, mole and other) to find out what the owl ate. By answering a series of questions, the students learned which animals influenced the owl population the most.

The last topic in the ecology unit was cycles of matter. The three main cycles discussed were water, carbon dioxide and nitrogen. The students were lectured on these cycles and then each group was assigned to draw all three cycles on poster board. After the drawing was completed, the students did an activity that demonstrated the carbon dioxide cycle in a sealed environment (See Activity 11, Appendix Q).

Most of the material (labs, activities, etc.) in this ecology unit were not original, although I did adapt several lab activities. I developed/adapted these activities while doing my summer research at Michigan State University in 1996. Keeping in mind the three learning styles, I also developed the structure of the ecology unit. Each of the thirteen ecology objectives was aligned with the 1998 MEAP ecology objectives. This unit was developed through researching activities and teaching strategies which addressed the three sensory modalities. Since every objective was taught using all three sensory modalities, every student had a chance to learn through their preferred learning style. The skeleton of this unit was taken from a conference on teaching ecology using two liter bottles. The "guts" of the unit - activities, lectures, videos, and labs - were taken and developed from a variety of sources.

The primary evaluation tool was the ecology final exam. Because this exam (See Ecology Final Exam, Appendix R) did not change from the years 1994 to 1997 and was based on the same objectives and materials, I could make valid comparisons between students taught with and without the ecotube. The test had questions ranging from multiple choice, true and false, essay, and matching.

EVALUATION

As stated previously, the same final exam was given to the eighth grade Life Science students from the fall of 1994 through the fall of 1997. In 1994 and 1995, the students were taught using the traditional method of teaching ecology, using filmstrips, videos, lectures and a few labs. In 1996 and 1997, the students were taught based on the ecotube with appropriate support activities. This was a new form of teaching for me that allowed the objectives to be taught using the three sensory modalities.

Table 1 is an overview of the evaluation of my ecology unit. It shows the year the unit was taught, before and after the ecotube. It includes the ecology final test average per class, the average quarter (term) grade, and the period of the day the class was taught.

Table 1 - Overview of the evaluation of my ecology unit before and after using the ecotube

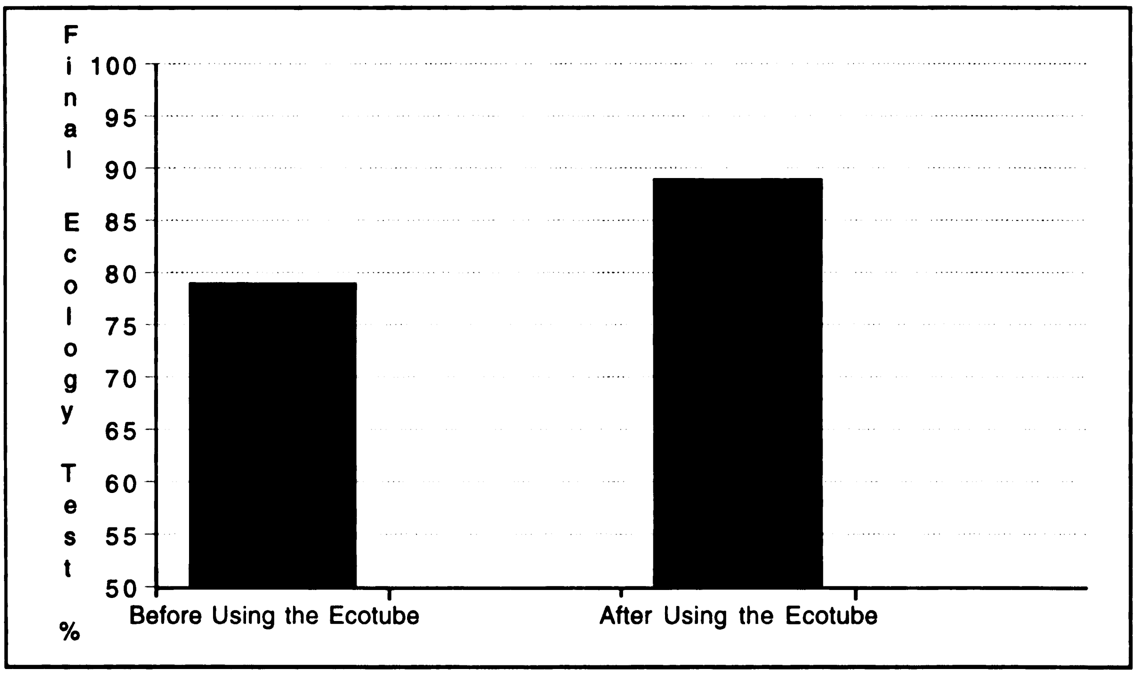
Before the Ecotube			
Year	**Ecology Test Avg.**	**Term**	**Period**
1994	79%	85%	6th
1995	84%	87%	5th
1995	75%	81%	6th
TOTALS	**79%**	**84%**	**3 PERIODS**

After the Ecotube			
Year	**Ecology Test Avg.**	**Term**	**Period**
1996	90%	86%	5th
1996	88%	77%	6th
1997	93%	94%	1st
1997	89%	89%	3rd
1997	95%	94%	4th
1997	82%	78%	5th
1997	83%	79%	6th
TOTALS	**89%**	**85%**	**7 PERIODS**

To determine whether the new unit helped to improve student performance, I had to know the basic skill level of each group of students. The students who were taught using the traditional method (n=84) in 1994 and 1995, had an average quarter grade of 84%. The students who were taught using the ecotube in 1996 and 1997 (n=117), had an average quarter grade of 85%. This establishes that these two groups of students were essentially of the same skill level.

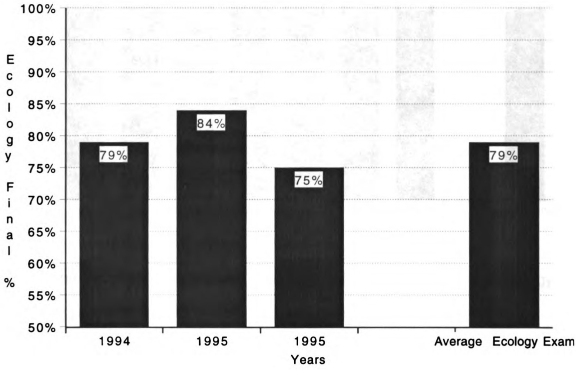
The results of the ecology final exam for both groups of students are shown in Figure 2. The exam covered all thirteen objectives with several questions on each objective.

Figure 2 - Results of final exam before and after using the ecotube



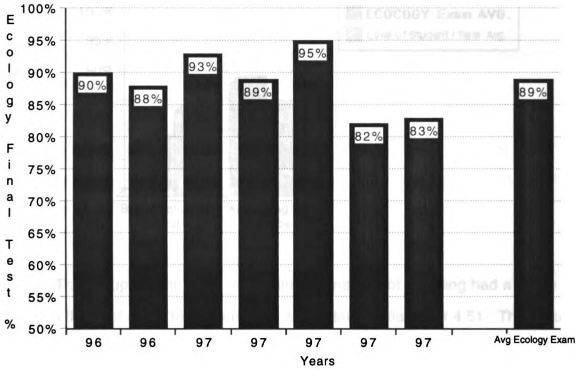
There was a 10% increase in the ecology final exam score when the students were taught using the ecotube. I suggest that this 10% increase was due to the way the ecology unit was taught to the students, using the ecotube as a basis of instruction. Figure 3 shows the results of the ecology final exams in 1994 and 1995.

Figure 3 - Final ecology exam before the ecotube



In 1994 (n = 28), only one class of life science was taught. In 1995, there were two classes taught (n = 53). The graph also shows the average final exam grade of the three classes. The science teachers in the Ionia Middle school wanted the test average to be around 85%. Since it was 79%, we knew we had to make a few changes in our curriculum. Figure 4 shows the final ecology test scores in the years 1996 and 1997, when the ecotube was incorporated into the unit. Notice how the scores for each year were above the 79% average of the students taught the ecology unit using a more traditional method.

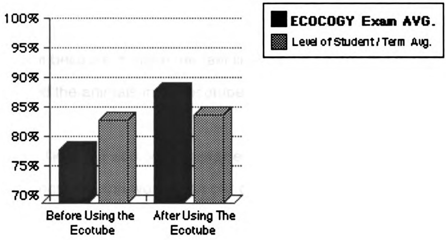
Figure 4 - Final ecology exam after using the ecotube



After the students were taught ecology using the ecotubes, the ecology final exam average was 89%. This was above the 85% that the science teachers used as an indicator of mastery. This was also above the 79% final exam average of the students taught using the traditional approach.

Figure 5 is a summary of the performance of the traditionally taught students and those taught using the ecotube. It shows the basic academic level of both groups of students and the average final ecology exam grades before the ecotube and after the ecotube was used as a teaching tool. The students did much better on their final exam when the ecotube was incorporated into the curriculum.

Figure 5 - Ecology final exams and level of students



The group taught using the traditional method of teaching had a mean of 79.3 on the final exam test scores and a standard deviation of 4.51. The group taught using the ecotube had a mean test score of 88.57 and a standard deviation of 4.79. Therefore by comparing the means a T - value of 1.404 was calculated. Using a degree of freedom consistent with the number of samples taken and a conservative significance level of .05, I found that the critical value is 2.228 which supports my claim that the scores after the ecotube unit were higher than without using the ecotube.

The students seemed to enjoy the unit. They were having so much fun that some of them did not know they were learning. Here is what some of the students said about the ecology unit, based on comments stated in an extra credit question:

*"I liked doing the ecotubes and watching everything change and how I can understand it better if I see it"

*"I really liked doing the ecotube lab because it showed us about life (producers and consumers) and it was fun, not some boring thing out of the book"

*"I liked it because it made me feel like I could control the environment and this effected the animals in the ecotube"

*"I really liked our ecology chapter especially when we learned about symbiotic relationships and worked on our ecotubes, this was one of the best chapters I was ever taught."

* "I like this unit a lot. At first, I thought it would be one of those stupid science things but it turned out decent. I can't remember one thing I disliked about this unit."

*"I liked how I could see it happen in front of me, it helped me to understand everything better. This was really cool!"

It really makes a teacher feel good when the students are saying things like, "This was our best unit ever taught", "I had a lot of fun", and "I learned more than I ever did." It was just chance that I came up with the idea of putting the ecotube and the MEAP objectives together. Putting the two together was like finding a missing puzzle piece. The students seemed to enjoy the unit more and remember more topics on the ecology unit.

This is summarized by comments from a below average student who did not do very well in seventh grade science.

He said "I liked this unit. This is like the best unit I have ever did. See at first I thought it will be just another unit that just did not make sense but I understood this unit a lot more than any other unit. I really began to enjoy it when our fish in our ecotube had babies and I never knew that a smell can pop out of no where and pretty much there was not one thing I actually disliked about this unit. This unit really helped me to understand science."

DISCUSSION AND CONCLUSIONS

The ecotube as a teaching tool was very effective according to the method used to evaluate its success. The content of the final exam given to students of similar academic ability did not change from 1994 to 1997.

The only way I knew to evaluate this unit was to use the ecology final exam. Knowing that the science department aligned all the tests with the MEAP objectives helped the evaluation process, it was then easy to use the same test to evaluate the effectiveness of addressing different learning styles using the ecotube as a tool. It was obvious, as evidenced by the statistical analysis, that the group taught using the ecotube learned much better (Figure 6).

I believe, and the evidence strongly suggests, that the most effective aspect of using the ecotube to teach the MEAP ecology objectives was its hands-on approach. Every day, the students were doing something with it. Working with eighth grade students was challenging because the energy level would easily become unbearable. A physical activity where the students were out of their seats doing an experiment, activity, or a check on their ecotube helped to dissipate some of this energy. The teacher also became a facilitator. When the teacher did this, the students learned on their own more easily.

Another effective aspect of using the ecotube is that it was a tool to teach to each of the three different learning styles. Since all students learn differently, the teacher needs to teach each objective with the three sensory modalities in mind. The outline of this unit was developed so that each objective was taught to each student using all three sensory perceptions. Each student in the class was given an opportunity to learn the objective using their own learning style.

The ecotube activities were ongoing and reinforced each objective. The activities tied to the ecotube were fun for the students, so the students did not even realize that they were learning.

As stated previously, the unit was effective from the instructor's perspective because the teacher became a facilitator. Seeing students learning on their own was something that a teacher rarely sees. Some days I had a certain objective planned to teach, but because the students noticed something happening in their ecotube, we changed direction. The lesson was changed to answer the students' question. For example, a prepared lesson on symbiotic relationships might have been delayed because the students saw decomposers on their fish. The teacher then focused on the decomposers on the fish, which allowed the students to learn about what they saw that day.

I was not prepared for the demands of this kind of teaching. Teachers who are accustomed to teaching certain things on certain days might have problems teaching this unit because the lesson may change depending on what is happening in the students' ecotubes. One day you might be talking about food chains and the next day you might be talking about the carbon cycle. The large amount of time required to set up materials is another demand the teacher has to be prepared for. Because of all the labs and activities in this unit, the teacher has to spend much more time outside of the classroom for preparation. The teacher also must do the labs before he or she assigns them to the students. There is a certain amount of *Elodea* and other biotic and abiotic factors that the ecotubes need in order for the organisms to survive. The teacher has to feed the fish a small amount of fish food every other day. We did this after school and then after the unit was over, we discussed what kept the fish alive. The teacher also has to be prepared to deal with fish dying. When this happens, it opens up a great opportunity to talk about decomposers, such as what they are and what their products smell like. The ecotubes must not get direct sunlight because they get too warm. The best condition is an artificial plant light shining directly on the *Elodea*. The teacher might want to establish two groups of ecotubes, one with an aerator and the other just with *Elodea*. This will ensure that some fish will live. Discussions went on throughout the classroom on why the fish with the *Elodea* survived without oxygen. This provided a great opportunity to discuss the carbon oxygen cycle. We discussed why only certain fish survived, which brought up an emotional issue. Some students have felt it is cruel to do the ecotube experiment. The teacher must discuss this issue before getting into the ecology unit. If the issue becomes too much for some students, other sources should be used to teach these students, such as worksheets, questions in books, and research. Out of the two years and one hundred and seventy-one students being taught this ecology unit, there was only one student that had a problem with the ecotube. This student, however, still did the activities and labs.

The ecology unit takes five to six weeks to complete, but could take anywhere from four to seven weeks. The teacher has to decide what is useful and what labs are most beneficial to his or her students. The teacher also has to understand that the ecotubes take about a week to make and become established before the unit begins. The science teachers at the Ionia Middle School felt that the "wasting" of one week is well worth what the students got out of the overall unit. The teacher has describe how to do the checks on the ecotubes very slowly, so the students avoid error.

The overall evaluation of using the ecotube to teach ecology is positive. The results on the final ecology test support the method of teaching ecology to middle school students. The results were so stunning that a teacher in high school or elementary school should not hesitate to use this style of teaching ecology. Modifications would be needed for these different levels, but the overall benefits of an ongoing lab, teaching using sensory perceptions, and other labs and activities would be worthwhile in any science unit.

APPENDICES

APPENDIX A

APPENDIX A

MEAP Ecology Objectives

VI.B.1.c.

Reinforce

Identify green plants as the source of all food eaten by people and animals.

Compare the roles for producers and consumers.

VI.B.1.d.

Introduce

Identify different types of relationships within an ecosystem

VI.B.1.c.

Introduce

Identify different types of relationships within an ecosystem.

VI.B.2.

Introduce

Contrast the flow of energy through an ecosystem with the cycles of nutrients in an ecosystem.

VI.B.2.a.b.c.

Introduce

Describe the major processes involved in the water cycle.

Describe the major processes involved in the carbon dioxide cycle.

Describe the major processes involved in the nitrogen cycle.

VI.

Reinforce

Define ecology as the study of how living things affect each other

VI.A.

Introduce

List abiotic factors and biotic factors.

VI.A.1.

Reinforce

Identify some structural and behavioral adaptations for a number of common plants and animals and explain how each adaptation helps the organism to survive.

VI.A.2.a

Introduce

Describe the interaction of abiotic and biotic factors

VI.A.2.C.

Reinforce

Describe succession as a series of changes that take place in the communities of an ecosystem.

VI.A.3.a

Introduce

Define population. What inhibits the growth of a population

VI.B.1.

Reinforce

recognize that an ecosystem is a group of living things and their non-living environment that interact with each other.

VI.B.1.a.b.

Reinforce

Explain an organism's habitat and niche in a community and distinguish between the two.

APPENDIX B

APPENDIX B

Preparing Bottles

Hints:

*Use 3 of the same brand of bottles for the column, they fit together best.
*Rinse out bottles, don't use soap as this can hurt plants and animals
*Make sure the water you use is not too hot (over 65 C or 170 F). The bottles will shrivel up if you do.

Removing the base and label

1. Fill bottles 1/8 way full with hot water (55 C or 120 F). A large coffee urn (like those used for meetings/banquets) works great. Screw top back on.

2. Let water melt glue holding label on. Peel off label.

3. Remove base from two bottles. Let the hot water melt the glue at the base. Twist off.

4. Remove cap and drain water into a container.

Marking and Cutting Bottles

1. Have Slot A measured between 18 and 20 cm from bottom. Slot B should be marked in the box between 10 and 12 cm. Mark bottles by turning them in a circle while holding a permanent pen in the cardboard boxes' precut slot.

Bottle 1- Aquarium This bottle is marked with slot A. Write A on the bottle, mark with pen, and cut.

Bottle 2- Connector This bottle with the base removed is marked with slot C and B. Write C on the bottle, mark and cut twice.

Bottle 3- Terrarium
This bottle with the base removed is marked with slot B. Write T on the bottle, mark and cut. Keep the base to cover the terrarium.

Completed Ecocolumn Insert bottles A, C, and T. Use a small piece of tape to secure the parts together. For a different way to make the ecotube see appendix D.

Setting up Plants for the Aquatic Ecosystem

1 - Obtain the bottle marked A. The base is attached.

2. Place one cup of gravel in the bottle. This becomes the floor.

3. Add water to the bottle until it is about 8 centimeters (cm) from the top. Measure the numbers of cm from the gravel floor to the top of the waterline. **(if you used tap water, fill a water container the night before and let stand. Or use a tap water conditioner that removes chlorine; it can be purchased at most pet stores.) Record this data in your journal.**

4. Add plant life.

*2 sprigs of *Elodea*
Measure the size of each sprig. Record the measurements. Place in Aquatic Ecosystem bottle.

*10-15 Duckweed plants. Scoop out the plants and record the number. Place in Aquatic Ecosystem bottle.

*4 droppers of algae.
Record what the algae looks like.

5. Compared the plants and record the data on the Aquatic Ecosystem on the sheet provided. Use a hands lens to "get close up." Record observations in your journal.

APPENDIX C

APPENDIX C

Modality Checklist

Place a check mark by all the statements that strongly describe what you prefer.

Auditory

_____ I need to hear myself say it in order to remember it.

_____ I often need to talk through a problem aloud in order to solve it.

_____ I memorize best by repeating the information aloud or to myself over and over.

_____ I remember best when the information fits into a rhythmic or musical pattern.

_____ I would rather listen to a recording of a book than sit and read it.

Visual

_____ I need to see an illustration of what I'm being taught before I understand it. I am drawn to flashy, colorful, visually stimulating objects.

_____ I almost always prefer books that include pictures or illustrations with the text.

_____ I look like I'm "daydreaming," when I'm trying to get a mental picture of what's being said.

_____ I usually remember better when I can actually see the person who's talking.

Kinesthetic

_____ I have difficulty sitting still for more than a few minutes at a time.

_____ I usually learn best by physically participating in a task.

_____ I almost always have some part of my body in motion.

_____ I prefer to read books or hear stories that are full of action.

APPENDIX D

APPENDIX D

Marking and Cutting Bottles (Another way)

1. Get labels off the bottle putting hot water inside the bottle too melt the glue on the label. Then peel off the label. Remove plastic bottom if your 2 liter bottles have them.

2. Cut bottles using directions below with sharp scissors:

Bottle one -- *Aquarium* - This bottle should be measured 11.5 cm from the top to bottom. Then cut and throw away top.

Bottle Two - *Connector* - Measure from top to bottom 25.5 cm and cut then measure 11.5 cm and cut. You should have three separate sections. Keep the middle.

Bottle Three -- *Terrarium* - Measure from top to bottom 25.5 cm. Keep both sections.

Completed Ecotube -- Put bottle two inside the big part of bottle one, narrow part should be inside terrarium. Then take bottle three and put it, narrow side down, inside bottle two. Use the little part of bottle 3 as the lid for your ecotube.

Getting Ecotube set up

Adding Animals to the Aquatic Ecosystem

1. Fill a clear plastic cup about 1/2 full of water from the holding tank.

2. Spoon two snails into the your cup.

3. Net two guppies and places them with the snails. **(Don't dump the animals into the ecosystem until completing step 4 and 5.)**

4. Use the hand lens to observe how the animals look, their movement, and how they act.

5. Use a dropper to slowly add water from your ecosystem to the plastic cup. Fill the dropper up and add the water until about half full. This slowly changes the water temperature so the animals aren't put into shock.

6. Gently pour the animals into the bottle.

7. Draw and label the parts of your Aquatic Ecosystem on the sheet provided. Make certain to show the details of the plant life. Use a hand lens to "get close up." Record observations in your journal.

Setting Up the Land Ecosystem

1. Use part T for the land ecosystem. Bottle C with a base can be used as a stand.

2, Remove the cap from part T. Rubber band a square of nylon to cover the bottle mouth.

3. Place part T with neck down in the part C. Add two cups of soil. Don't muddy the sides.

4. Divide the soil surface into four equal parts (see picture below). Use toothpicks to set up a grid.

5. In three of the parts seeds are to be planted.

   *To begin with, count out 20-30 seconds and record the number of alfalfa seeks. Drop the seeds evenly on to the surface of the soil. Next, with your tooth pick, spread the seeds and press them into the soil.

   *After the alfalfa is planted in the proper section, do the same with the grass and mustard seed.

   *To wet the soil use the water dropper. Count the drops of water added to the soil. Do this until it begins to leak from the bottom. Then replace the cap. Every time water is added, record the number of drops before it runs out the bottom.

6. In the last section add material such as a small rock, leaves, twigs, or other plant litter.

7. Draw and label the parts of your Land ecosystem in your journal. Make certain to show the details of where seeds were sown, the plant material added, etc.

Adding Animals to the Land Ecosystem

Isopods

1. Scoop up two isopods into a plastic cup. Watch them in the cup for about five minutes. Record observations in your journal. Draw the isopods. Include color, shape, body parts, etc.

2. Place the isopods into the vegetation growing in the top of the land bottle. Watch them for a few minutes and record your observations.

Crickets

1. Capture two crickets and place them in a plastic cup.

2. Cover the cup with an index card. Take the cricket to a comfortable place to observe with a had lens.

3. Write down and questions that you might have about the cricket. Record your observations i your journal. Included color, shape, body parts, etc. Draw the cricket.

4. Place the crickets in the Land Ecosystem. Cover them quickly. Observe their behavior for three minutes. Record your observations.

APPENDIX E

APPENDIX E

Check	# of Duckweed	Inside Bottle Feel	Dead Things Observed	Other Observations
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

Check	Smell cf Water	Water Temp.	Algac on Rocks (%)	pH of Water	Water Color (Cloudy/Clear)	Growth of Elodea (Cm)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Check	Alfalfa Growth	Grass Growth	# of drops of water	Mustard Growth	Other Growth	Dead Things
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Check	Water on inside of bottle (y/n)	New Organisms	Dead Things	Other Observations
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

APPENDIX F

APPENDIX F

Succession Drawing

Below draw your ecotube how it looks now. (Check 1)

APPENDIX G

APPENDIX G

What is a living thing?

1. What is an ecosystem?

2. Which one looks more alive the land ecosystem or the water ecosystem?

3. Pick one living thing in your ecosystem. What is it?

List 3 reasons why it is alive 1.

2.

3.

List 9 features of life below	Explain why your organism has the feature
1.	
2	
3.	
4.	
5.	
6.	
7.	
8.	
9.	

5. List 5 abiotic factors 1. 2. 3. 4.

5.

6. List 3 biotic factors- 1. 2.

3.

7. Can the biotic factors live without the abiotic factors:

How can we test this?

8. What are 4 different populations in the bottle

1. 3.

2. 4.

9. Name 2 communities in the bottle by naming some populations that live together:

1

2.

10. Why is this bottle like our biosphere?

APPENDIX H

APPENDIX H

Biotic Factors in the Soil

Background:

Soil does not look like it has any biotic factors in it. However, you can test to see if there are any biotic factors in the soil. You know that most living things use oxygen. There is a substance that turns clear when oxygen is being used. This substance is **METHYLENE BLUE.**

Observe:

Soil that seems to have no living things in it.

Question:

Is there living things in the ______________________?

Hypothesis:

<u>**If**</u> I put methylene blue in the soil <u>**then**</u> it will turn_______________.

*This means something is using oxygen and that something is probably living things.

Experiment:

1. Label three test tubes A, B, and C.
2. Add the following to each test tube,
   A = 1 gram of sugar, 10 ml methylene blue. Caution- Methylene blue stains M
   B = 1 gram of sugar, 10 ml methylene blue and 1 gram of soil.
   C = 1 gram of sugar, 10 ml methylene blue and 1 gram of heated soil.
3. Stopper and shake each test tube for 30 seconds.
4. Record the color of each substance in the chart below:

<u>**Record only: Blue, Medium blue, Light blue or clear.**</u>

5. Allow to sit overnight.
6. The next day do not shake the test tubes, but record what you see and put recordings in <u>**Day 2**</u> column.

Questions:

1. Why did you heat the soil up?

2. What color do you predict the heated up soil test tube will be after day 2 and why?

3. What color should the test tube with soil in it turn and why?

4. Which test tube is your control?

5. What is the one variable in your experiment? (Remember, it is the one thing you are changing.)

6. Why did you put sugar in some of the test tubes?

7. Would you expect the tube with the sugar in it to turn color? Why or why not?

Conclusion:

Is your hypothesis TRUE OR FALSE and why?

APPENDIX I

APPENDIX I

Population Density

1. What is a population?

2. What is population density?

3. Why is finding population density important?

4. To find population density you

5. To find the population density of your classroom you need to first find the area of your classroom by:

LENGTH TIMES WIDTH =

INDIVIDUALS =

POPULATION DENSITY =

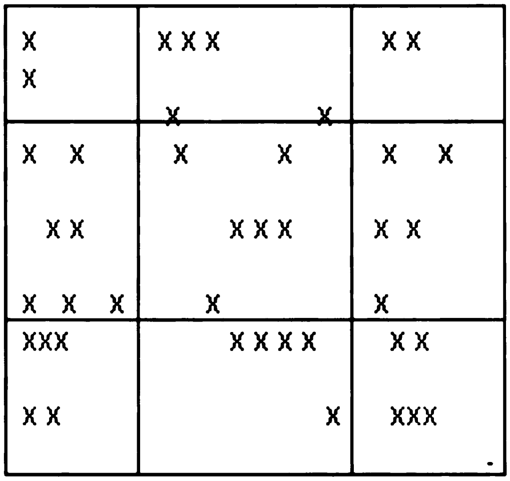
6. What is the population density of the plants in your bottle ecosystem,

3.13 times radius squared =

Seeds =

Population density =

7. When you have a population with many individuals, you can divide the population in sections and figure the population in one section and multiply it by the number of sections, Do this with the diagram below



NUMBER OF ORGANISMS IN A SQUARE =

NUMBER OF SQUARES =

MULTIPLY THESE TWO NUMBERS =

POPULATION =

8. Is this an exact count?

9. What are the positives to using this method:

10. What are the negatives to using the above method:

11. Find the population of plants in your ecosystem using this method:

Population of plants =

APPENDIX J

APPENDIX J

Water Saltiness and Brine Shrimp Limiting Factors

Background:

Brine shrimp are tiny crustaceans that live in the ocean and in salt water pools called estuaries, where fresh water meets salt water. Their dried eggs can survive a long period of time and under the right conditions will hatch when stimulated by the right conditions. One of these conditions is the amount of salt in the water around them.

Observe:

Brine shrimp eggs hatching.

Question:

At what percent of salinity will the most hatch?

Hypothesis:

If I put the salinity of the water at (0%, 2%, 4%, 8%, or 10%) then more brine shrimp eggs will hatch.

Experiment:

1. Number petri dishes 1 to 5.
2. Add the following measurements as shown on the table below to cups-l to 5.

Cup Number	Amount of water to add	Amount of salt to add	% of salt solution
1	100mL	0g	0%
2	98mL	2g	2%
3	96mL	4g	4%
4	92mL	8g	8%
5	90mL	10g	10%

Adapted from Scott, Foresman, Life Science, Copyright 1990

3. Pour the contents in cup one in a petri dish labeled 1, So that the petri dish is half full. Dump out the rest. Do the same to cups 2 - 5 and petri dishes 2 - 5.

4. Count out 20 brine shrimp eggs and put them into petri plate one. Do the same with petri plates 2 - 5.

5. Put the petri plates where the room temperature will remain constant.

6. Study the petri plates the next day. Observe each dish with a hand lens and count the number of eggs and number of hatched shrimp. Record it under day one on table 2.

7. Examine the petri plates for two more days. Record your observations.
table 2

QUESTIONS:

1. In which petri plate(s) did the brine shrimp hatch? Which day did most of them begin to hatch?

2. In which petri plate did the most brine shrimp hatch?

3. What percent of brine shrimp salt solution provided for best environmental conditions for hatching?

Conclusion:

1. Is your hypothesis true or false?

Extra:

1. Water in estuaries has a saltiness of approximately half that of the oceans, approximately 3%. Use this information to infer which of your experimental conditions were most like the natural environments in which brine shrimp are found.

APPENDIX K

Activity 6
Limiting Factors

1. What is a limiting factor?

2. Name two examples of limiting factors:

Question: Is temperature a limiting factor for the germination rate of a mustard seed?

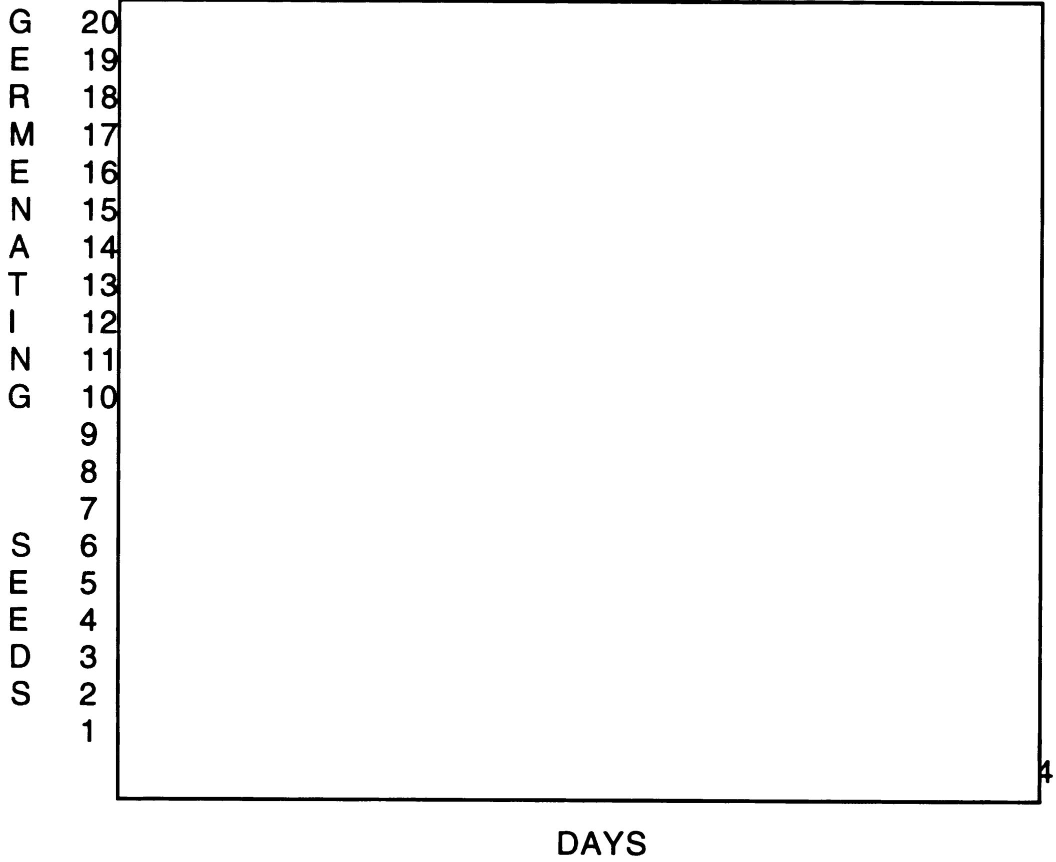
Hypothesis:

Experiment:

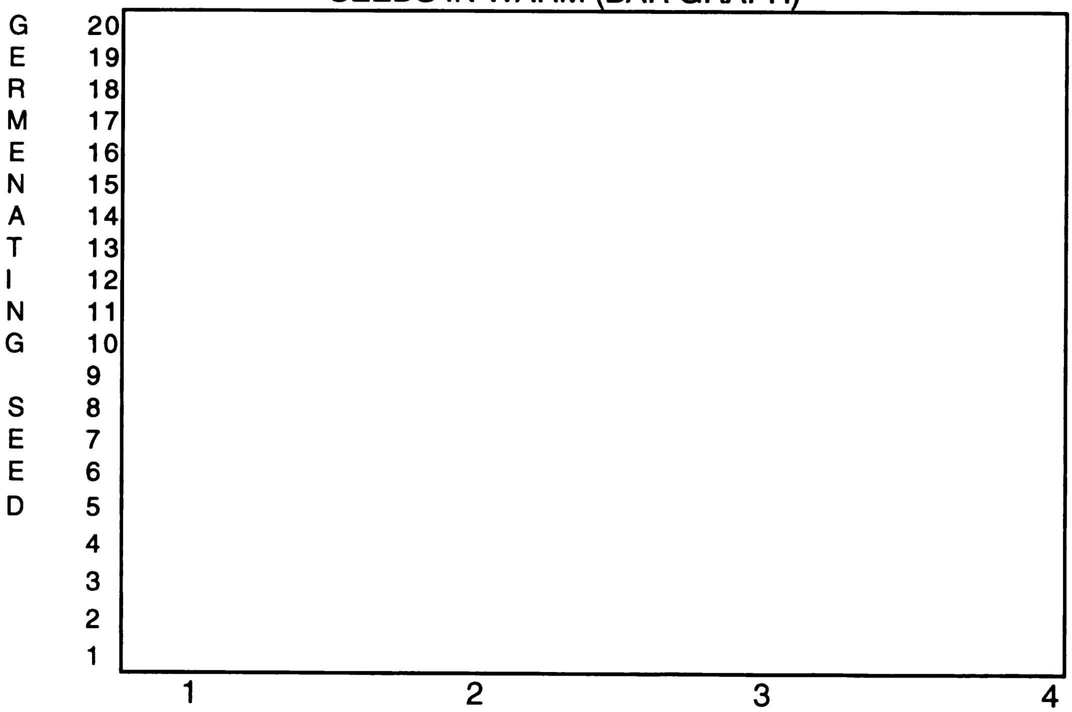
1. Take a petri plate and put a paper towel on the plate. (Filter paper will also work.)
2. Soak the paper towel with 100 drops of water.
3. Do step one and two with another petri plate.
4. Spread out 20 mustard seeds on each plate.
5. Cover each dish with the top of the petri plate. Put tape on the outside of the plate to prevent water from escaping.
6. Put one in the cold, another in a warm place and the last one in an incubator at 40 degrees Celsius.

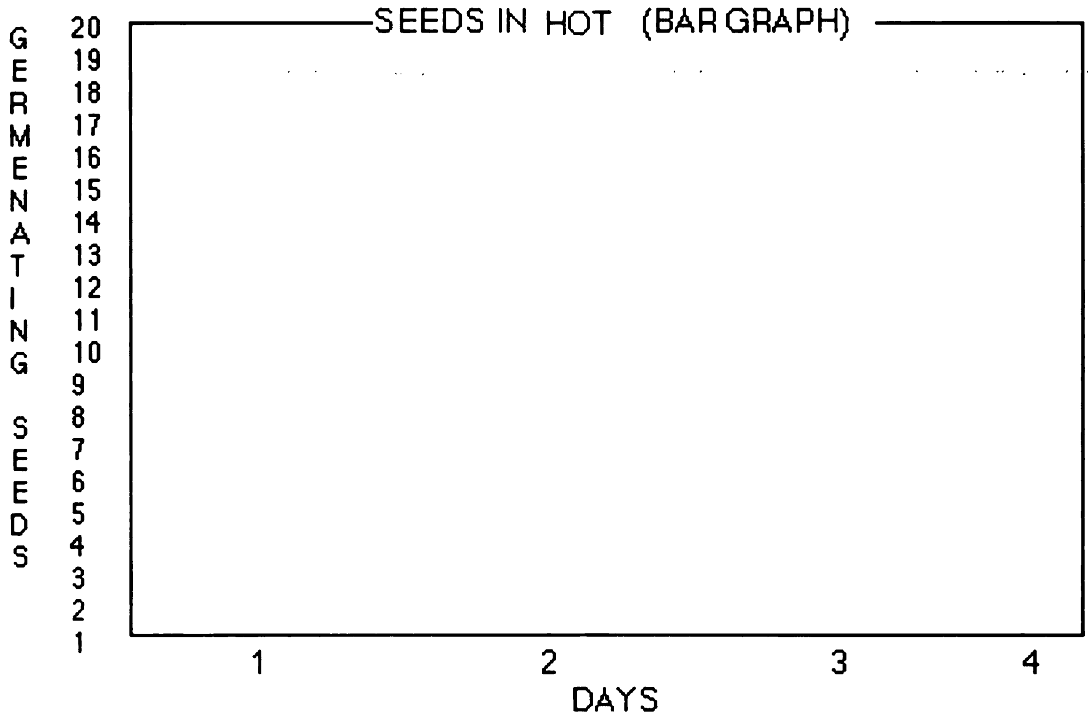
Adapted from Scott, Foresman, Life Science, Copyright 1990

SEED IN COLD (BAR GRAPH)



SEEDS IN WARM (BAR GRAPH)





QUESTIONS:

1. Which grass looked healthier? How did it look healthier, and why was it healthier?

2. What does this experiment have to do with competition?

3. How would this experiment help you plant grass better?

4. What would happen to any organism if overcrowding occurs?

APPENDIX L

APPENDIX L

Activity 7
Consumer and Producer

1. What is a producer?

2. What is a consumer?

3. How do producers get their energy?

4. How do consumers get their energy?

5. Knowing how they get their energy from where does the producer and consumer ultimently get their energy from?

6. Name two consumers in your ecotube?

7. Name 3 consumers in your ecology in a bottle?

8. How can you tell if it is a producer or a consumer?

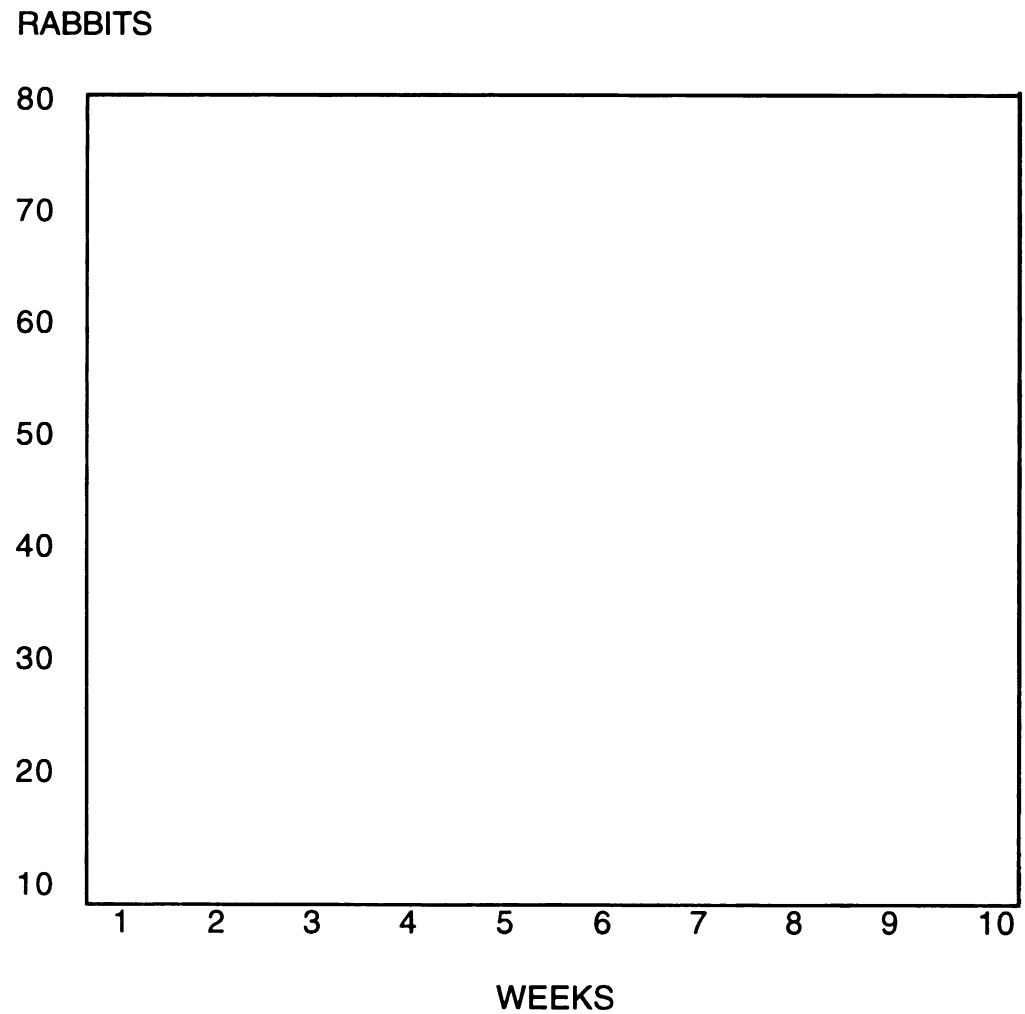
9. What would happen if we took all the producers out of the bottle?

10. What would happen if we took all the consumers out of the bottle?

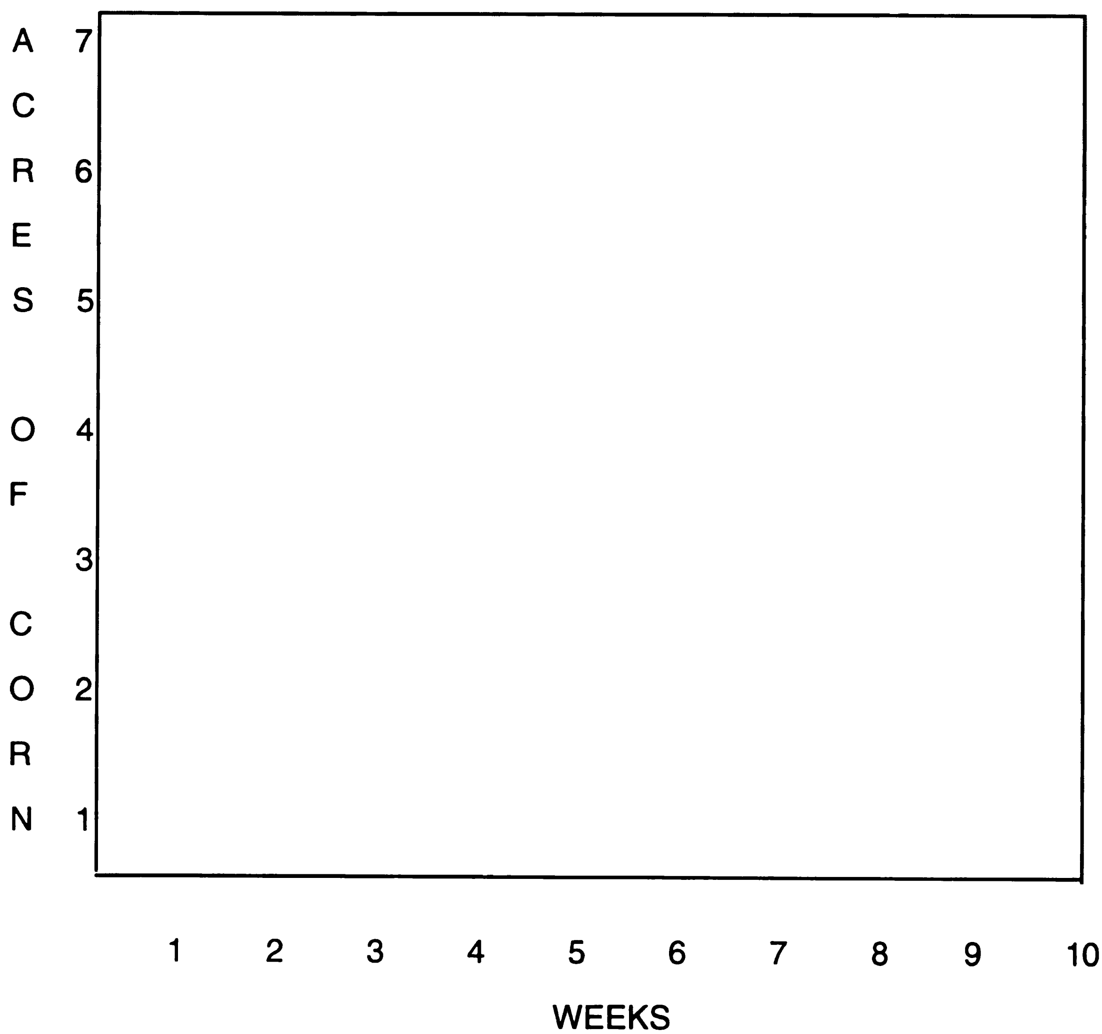
11. Graph out the population of corn with the population of dear:

	POPULATION OF RABBITS
WEEK 1	80
WEEK 2	60
WEEK 3	57
WEEK 4	52
WEEK 5	50
WEEK 6	41
WEEK 7	18
WEEK 8	22
WEEK 9	27
WEEK 10	37

DEER POPULATION IN A 10
WEEK PERIOD



	POPULATION OF CORN
WEEK 1	6
WEEK 2	4
WEEK 3	4
WEEK 4	3
WEEK 5	3
WEEK 6	4
WEEK 7	7
WEEK 8	7
WEEK 9	6.5
WEEK 10	5.5



APPENDIX M

APPENDIX M

Competition

Background:

When there is competition, the environment is affected. The niche, habitat, growth, or even reproduction is affected. We will see if the growth of grass seeds is affected by overcrowding.

Observe:

Observing two lawns. One yard, the grass is growing great. In the other yard is not growing great.

Question:

I wonder if planting too much seed can effect the growth of the

Hypothesis:

If I plant a lot of grass in one area **then** it will be (larger / shorter) and (thicker / thinner)

Experiment:

1. Put two cups of soil in a glass.

2. Label the cups A and B.

    * In cup A put a hand full of grass seeds and cover them with dirt.

    * In cup B spread out 35 seeds and cover them with dirt.

3. Wait 5 days and record in the chart below, then graph the results on the last page.

* Make a table using the data from your grass.

4. When you take the 30 blades of grass, it is easier to take scissors and snip a bunch of grass from the dirt and count out 30. Do not pull the grass out by hand, just use the stalk of the grass.

APPENDIX N

APPENDIX N

Predator Prey Experiment

Background:

In nature an animal is either a predator or a prey. A predator is an animal which hunts down another animal and a prey is what is being hunted. An example is a lion is a predator and its prey would be a deer. Now an animal can be a predator and a prey. Like a lion can also be a prey, when humans are the predator.

First Experiment:

1. With 25 students use 25 peanuts and:
    * Distinguish 2 of the students as being OWLS. Use a sign paper or something.
    * Distinguish 5 of the students as being BIRDS.
    * Distinguish 13 of the students as being grasshoppers.
2. Give each student a peanut. (On 7 of the grasshopper peanuts put a small blue dot, this shows that there is poison in those grasshoppers)
3. Find an area about 100 ft. by 100 ft. and spread the students out then say, " Go". The birds should try to catch the grasshoppers and if they do catch
   the grasshoppers the grasshopper sits down and give that peanut to the bird. The owls have to try to catch the birds and if they do the birds give their peanut to the owls. After 15 seconds say, "Stop". Then the students should fill out the attached sheet.
4. If the birds do not capture at least 2 grasshoppers they die and are out of the game. If the owl does not capture at least one bird they are out of the game.
5. You can also use the blue dot as pollution and see where all the pollution gathers in a food chain.

Second experiment:

1. Divide the students the way you did in the 1st step of the first experiment.
2. Don't give any students peanuts.
3. Find an area about 100 ft. by 100 ft. and spread the students out and say, "Go". The same rules apply in experiment one but when the bird catches the grasshopper the grasshopper becomes a bird, this is because they live longer and reproduce. Same applies to the owl, but they need to capture the birds.
   What happens to the population of Birds, Grasshoppers, and owls?

Type of Animal ______________________________

Rounds	# Captured	Blue dot

APPENDIX 0

APPENDIX 0

Adaptations

Background:

Every organism has adaptations. An adaptation is a trait that helps an organism survive. Cheetahs have speed, turtles have shells, and bears have strength. Brine shrimp also have adaptations that helps them to survive. There are two types of adaptations that enable the success of an organism, structural and behavioral adaptations. You will find the structural and behavioral adaptations of brine shrimp.

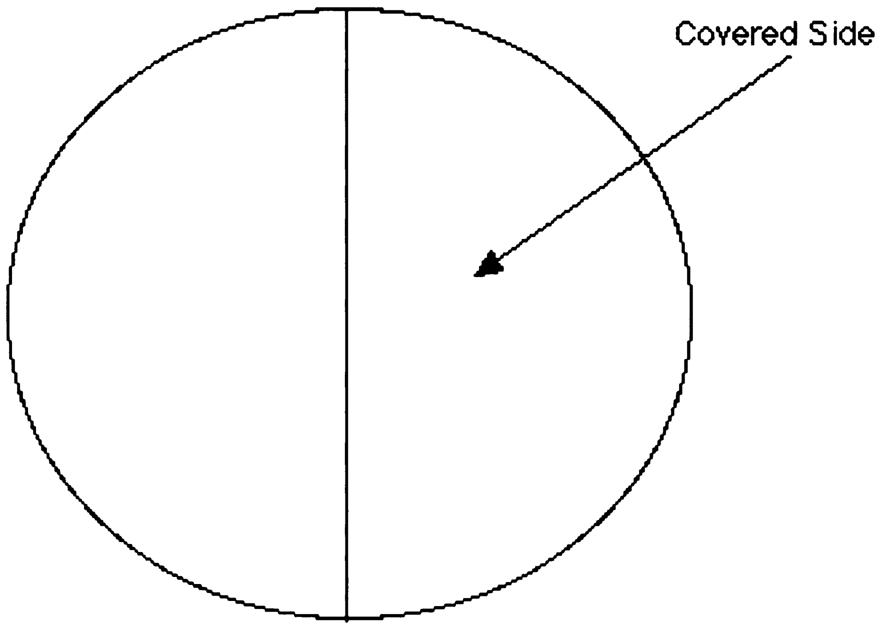
More Background:

Brine shrimp are crustaceans. They like to live in a weak salt solution. They feed off the algae on the top of the water.

Behavioral Adaptations

Procedure:

1. Get a solution of brine shrimp and put it in the petri plate.
2. Put a paper towel over half the petri plate and watch where the brine shrimp go.
3. Wait for one minute and take the towel off the plate. Below draw where the brine shrimp were located when you took the towel off.



Adapted from Merrill Biology, Biolab Worksheets, Copyright 1991

Questions:

1. Where were most of your brine shrimp located, in the light or dark?

2. What is a behavioral adaptation?

3. Why would it be better for the brine shrimp to be located in the light?

4. Is this a structural or a behavioral adaptation? Why?

Structural Adaptation

Procedure:

1. Take one brine shrimp and put it on a microscope slide.

2. Look at it under low power and draw it below.

3. What is the definition of a structural adaptation?

4. Below list three structural adaptations and tell how they help the brine shrimp survive.

	Structural adaptations	**How they help brine shrimp survive**
1.		
2.		
3.		

APPENDIX P

APPENDIX P

Activity 10

Owl Pellet

Background:

An owl is a carnivore so it eats meat. You can determine the prey of an owl by looking at its pellets. An owl pellet is the substance an owl does not digest. The owl regurgitates the substances that it can not digest in a little ball called a pellet. You are going to look at a pellet and find what animals the owl depends on for survival.

Experiment:

*Put safety goggles on.

1. Take an owl pellet and with your instruments carefully dissect it.
2. Divide the types of skeletons in piles.
3. By using the pictures on the back page decide if the animal the owl ate was a rodent, shrew, mole or another animal.
4. Below put the number of animals found in the chart below.

Individuals Results

Animal	**# of animals found**
Rodent	
Shrew	
Mole	
Other	
Total #	

Adapted from Scott, Foresman, Biology Laboratory Manual, Copyright 1995.

5. Get a total of animals found in your class and find a percent of them by dividing each animal by the total number of animals found, do this below.

Class Results

Animal	Number of animals Found	Percent of Animals
Rodent		
Shrew		
Mole		
Other		
Total Number		

6. Which organism would effect the owls health the most if the grass was sprayed with a carcinogen or DDT.

7. Assume that owl that produced your owl pellet produces one pellet every day. Estimate the owl's annual consumption of each animal: **TIMES EACH ANIMAL BY 365.**

RODENT =

SHREW =

MOLE =

OTHER =

8. Which animal would effect the owl the most if it had a decline in number or went extinct

9. Assume a mole weighs 110 grams, rodent 25 grams, and a shrew 3 grams. Compute the average weight in grams of each of the owls prey in an annual diet. Rank each animal from importance in the owl's diet. Use your individual data.

Rank **Grams**

Rodent =

Shrew =

Mole =

10. From what you know about an owls diet you should be able to draw a food web starting with the sun and ending with the owl. Remember a food web is overlapping food chains.

11. Why do animals at the top of the food web considered the most threatened organism in a community that is exposed to such poisons. Are we at the top of the food web?

12. Draw three food chains to make a food web of your ecology in a bottle below.

APPENDIX Q

Appendix Q

Demonstrating the Carbon Cycle in a Sealed Environment

Background:

Elements are cycled through the environment. These cycles include the nitrogen cycle, water cycle and the carbon cycle. Carbon is found in all living things and needs to be cycled or else living things will die. One way this happens is when animals give off carbon dioxide during respiration and plants take this carbon dioxide in during photosynthesis. We will be observing this cycle in a sealed environment.

Procedure:

1. Pour 150 ml of aquarium water into a beaker and add one to two ml of bromothymol blue.
2. Put four test tubes on a test tube rack. Label the test tubes A, B, C, and D.
3. Pour 4/5 of aquarium water in each test tube.
4. Test tube A = Don't put anything in it.
   Test tube B = Put 2 snails
   Test tube C = Put Elodea
   Test tube D = Put Elodea and snails.
5. Record under day one in your data table. Observations should include color of water (Blue, Light blue, Green, Yellow or clear).

Test tube ----> A B C D

Day	Aquarium Water	Snails	Elodea	Elodea/Snails
1				
2				
3				

Adapted from Scott, Foresman, Biology, Copyright 1991

Questions:

1. Which test tube is your control. (A,B,C or D)?

2. Increase amounts of carbon dioxide will change the color of the water to ____________.

3. Which test tube will turn clear? Why?

4. Which test tube(s) will not change? Why?

5. Which test tube did the organisms remain alive? Why?

6. Where did the snail in the fourth tube obtain its oxygen for respiration?

APPENDIX R

APPENDIX R

Ecology Test

I. Matching: Match the letter with the correct statement below'.

A. Biology	D. Microbiologist
B. Zoologist	E. Ecologist
C. Botanist	F Anatomy

1 .________ A person studying pollution, or the environment.

2. ________ A person who studies animals.

3. ________ A person who studies structures.

4. ________ A person who studies small living things.

5. ________ A person who studies living things.

6. ________ A person who studies plants.

II. Short Answer:

7-9. There are a frog and a rock lying next to each other on a table. What are some features of the frog that make it alive:

7. 8. 9.

10-11. What are two needs that frog has to have in order for it to be considered alive

10.

11.

12.

III. Matching:

A. Abiotic B. Biotic C. Niche D. Habitat E. Predator F. Prey

12________ A squirrel eats nuts and gathers leaves.

13.________ An animal that gets eaten. Like that rabbit and the hawk, the rabbit is this.

14. ________ Water or carbon dioxide is this, a nonliving thing.

15. ________ A tree or an animal is this, a living thing.

16. ________ The animal that eats things, like the hawk and the rabbit, the hawk is this.

17. ________ The squirrel lives in the tree, the tree is this.

IV. Short Answer

18. Define an ADAPTATION -

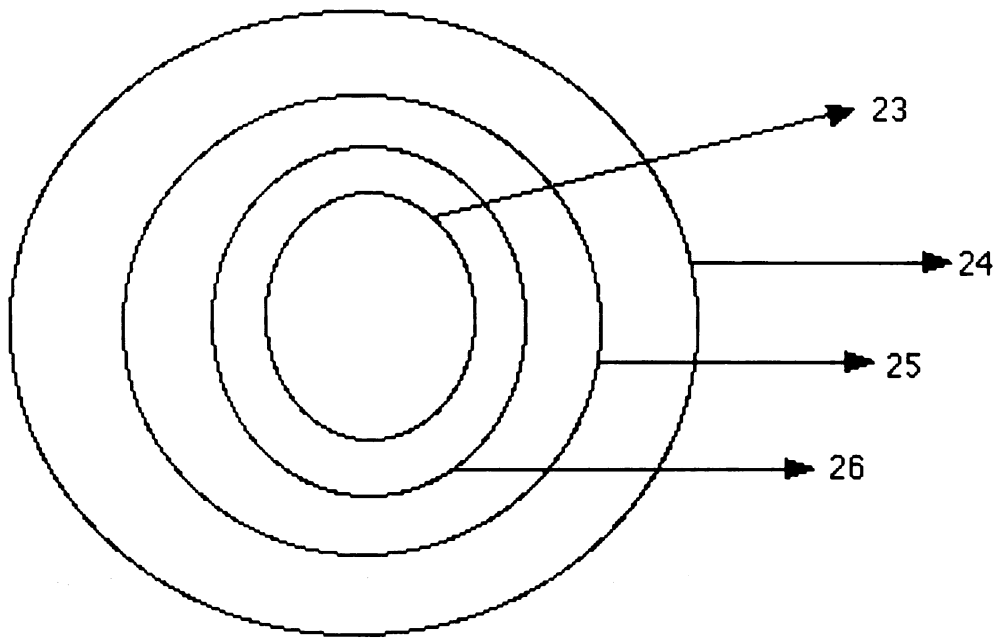
19. Name a structural adaptation:

20. Name a behavioral adaptation

21. When a deer used camouflage to hide in the dark brown weeds during hunting seasons, is the brown coat on the deer a structural or behavioral adaptation?

22. When a walking stick used mimicry to hide from the predators, the parts on the walking stick's body a structural or behavioral adaptation?

VII. Put in the circle below where POPULATION, COMMUNITY, INDIVIDUAL, AND ECOSYSTEM belong in the center of the circle is greater in number and the farther you go outside the more abundant the organisms.



27. How are strength and health effected by overpopulation?

VII. Matching

A. Limiting Factor
B. Primary Succession
C. Secondary Succession

28. ______ When a volcano forms and a new land area is created in the ocean.
29. ______ When a forest fire burns down the woods of previously existing land area.
30. ______ What an organism needs to survive.

V. Multiple choice

31. _______ An organism that makes its own food.
a. Producer
b. Consumer
c. Decomposer

32. _______ An organism that gets its own food.
a. Producer
b. Consumer
c. Decomposer

33. _______ A consumer that eats only vegetables.
a. Omnivore
b. Carnivore
c. Herbivore

34. _______ A consumer that eats only meat.
a. Omnivore
b. Carnivore
c. Herbivore

35. _______ A consumer tat eats both meat and vegetables.
a- Omnivore
b. Carnivore
c. Herbivore

36. _______ What part of the food chain turns dead material into a usable form of energy.
a. Scavenger
b. Producer
c. Consumer
d. Decomposer

VI. Label what type of symbiotic relationship it is,

Mutualism Parasitism Commenselism

37. _______ Where both organisms benefit.

38. _______ Where one benefits and the other is harmed.

39. _______ Where one benefits and the other is neither harmed nor benefits.

VII. Multiple Choice

40. _______ When the crab puts anemones on its back and both organism are helped
a. Parasitism
b. Commenselism
c. Mutualism
d. None of the above

41. _______ When a leach sticks to your skin to suck your blood
a. Parasitism
b. Commenselism
c. Mutualism
d. None of the above

42. _______ A mouse eats some grain containing a kind of bacteria. That bacteria begin to live in the mice' intestines and cause the mouse to become sick. That bacteria are most likely
a. Predators
b. Scavengers
c. Carnivores
d. Parasites

VIII. Fill in- Use the words below to answer questions 43-46.

Energy pyramid Carnivore Food chain Decomposers

43. __________ Shows the loss of energy in a food chain.

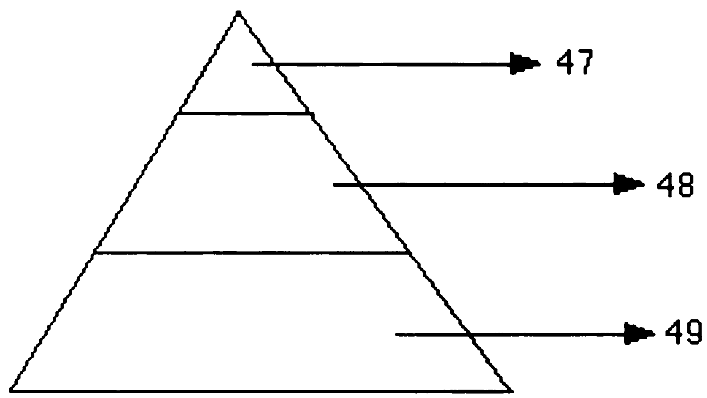
44. A lion is a ____________ because it eats only meat.

45. A ______________breaks down food into a usable form of energy.

46. A ______________shows the flow of energy from organism to organism.

VIIII. Label the pyramid below.

C= Carnivore P= Producer H=Herbivore



50. Can we use nitrogen can be fixed onto another element.

52. Name one way nitrogen is used in an organism.

53. Name one thing you learned from your ecotubes.

54. Name the three steps in the water cycle in order.

APPENDIX S

APPENDIX S

Ecology Unit Outline

1. **Ecology**
    - A. **Features of Life**
        1. Biosphere
        2. Biotic
        3. Abiotic
    - B. **Population**
        1. Population Density
    - C. **Community**
    - D. **Ecosystem**
    - E. **Succession**
        1. Primary succession
        2. Secondary succession
        3. Climax community
        4. Limiting factors
    - F. **Organisms are either**
        1. Producers
        2. Consumers
    - G. **Feeding relationships**
        1. Competition
            - a. Niche
            - b. Predator, prey
        2. Adaptations
            - a. Behavioral adaptations
            - b. Structural adaptations
                - 1b. Camouflage
                - 2b. Mimicry
        3. Symbiotic relationships
            - a. Mutualism
            - b. Parasitism
            - c. Commencelism
    - H. **Food chain**
        1. Food web
    - I. **Energy pyramid**
    - J. **Cycles of matter**
        1. Water cycle
        2. Carbon dioxide cycle
        3. Nitrogen cycle

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