This is to certify that the

thesis entitled

Mastery Learning in Ecology

presented by

Tammy L. DeBaar

has been accepted towards fulfillment
of the requirements for

MS degree in Interdepartmental
Biological Science

Major professor

Date 24 November 1998

MASTERY LEARNING IN ECOLOGY

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements for the
degree of

MASTER OF SCIENCE

College of Natural Science
Division of Science and Mathematics Education

1998

ABSTRACT

MASTERY LEARNING IN ECOLOGY

By

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Mastery Learning as a basis for teaching Ecology was chosen for this study to provide lower learning capacity students with motivation for learning science. Mastery learning allows these students the freedom to choose methods of learning that reflect their learning styles. I chose the unit of Ecology because it is the first and longest unit I teach. By studying the effects of this teaching technique early in the year, I was better prepared to provide proper activities the rest of the year. By providing a variety of different activities, students were able to choose activities that matched their work preferences (most often areas they feel successful in), and to raise their scores to the scale of mastery (80%). These areas were indicated by preferences the students made in their choice of learning activity. The student's overall attitude toward science was increased with their success, and attendance also increased as a result.

ACKNOWLEDGEMENTS

Without the advice and encouragement of Dr. Martin Hetherington, Dr. Howard Hagerman, and Dr. Merle Heideman, and the funding of both the Towsley Foundation and the National Science Foundation, this thesis would not have been possible. I also appreciate the insight and cooperation from my students and department peers. They are full of much needed help and never lack ideas. Furthermore, I thank my daughter for her patience with me for the time and energy put into this project and for being so forgiving that I could not play another round of catch or read another book.

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INTRODUCTION

Demographics of school and community:

Mastery Learning is the application of lessons in the classroom with the goal of helping each student achieve mastery on material (in this case, a minimum score of 80%). Mastery allows them to build a bridge to further their learning of the material and all material forthcoming. Level of mastery is determined by frequent feedback by means of quizzes on subunits of information. The students are separated into two categories at this time: those who achieved mastery (minimum 80% score) and those who did not. Mastery Learning is also intended to develop a sense of success in those students who do not otherwise succeed by traditional methods of instruction.

Mastery Learning was first described in Bloom's Learning for Mastery model in 1968. Professor Benjamin S. Bloom of the University of Chicago was seeking ways for

teachers to provide higher quality learning experiences for individual students within the classroom setting. He first examined the traditional curriculum in which the teacher follows a prearranged curriculum in a prearranged time frame to cover a predetermined set of chapters from a textbook(Bloom, 1971).

This method of teaching and learning is different from traditional methods of classroom instruction because of the focus on mastery of the subject, and the variety of modes of instruction to assist the students that do not initially achieve mastery. These modes are based on the different types of intelligence, or rather, the different ways of processing information, depending upon the individual's feeling of success in certain areas (Baum, 1995). Because I was unable to complete a survey of the intelligences of the students in this study (for lack of time due to departmental constraints) I assume that students choose work that they feel successful doing. These will be referred to as "work preferences" and are expected to indicate areas of talent for the individual student. I have included specific examples of these preferences related to themes of Ecology. They are as follows:

1.) **Verbal/Linguistic-** The student produces poetry, essays and oral interpretations such as an essay contrasting

the different types of climates in different biomes indicating the verbal- linguistic learning style.

2.) **Logical/Mathematical-** The student produces creative solutions, inventions, or experiments and indicates a logical-mathematical style. For example, the student may work on a local environmental concern.

3.) **Visual/Spatial-** The student produces advanced art, photography, models or maps, such as a detailed map of a woodlot plot in which areas are monitored for change in animal habitat for flora growth. These work preferences show a visual-spatial work preference.

4.) **Body/Kinesiology-** In this area, the student produces advanced creative game strategies, theater, machines or inventions such a board game using review questions on habitats and communities. These are "doing" exercises.

5.) **Music/Rythym-** If the student produces advanced compositions, rhythmic patterns or vocal interpretations, such as a rap song about food chains, they are likely talented in the area of the musical-rhythmic learning style.

6.) **Intra-personal-** A personal philosophy and moral systems about a topic such as " man's impact on the environment" might be produced by a student with strong intra-personal skills which are found in students that have a strong sense of their own values and morals.

7.) **Rules/Systems-** If the student researches opinions of community members on an environmental disaster and chooses to defend opposing opinions in a role play his work preference is likely to be inter-personal in which advanced creative laws and rules and political systems are designed.

Students in this study were primarily tenth grade high school students in my Life Science classes at a high school in a rapidly growing rural area. The school was named Michigan Exemplary School in 1992 and is a large class A high school. The community is unusual in that there are basically only two socio-economic groups: upper level, consisting primarily of doctors and lawyers and lower level, made up of inconsistently employed factory workers, often unable to support their families. During my four years as a teacher in this community, the county has been ranked one of the highest in the State of Michigan for unemployment, and one of the highest in the nation for teen pregnancy. The students in this study are mostly from families of the latter type, and are often overheard saying " I'm a dirt head and will always be a dirt head." They see no real reason nor have desire to better themselves and feel they are destined to be poor forever. Many of their families are dysfunctional; many of them are being raised by guardians other than their parents, and receive little, if any, support from home.

Both classes for this study consisted of approximately 25 students. They primarily are 10th and 11th graders, lower income students with relatively poor reading levels, poor organizational skills and study habits. They have been through traditional educational methods of merely "moving on" to the next topic, whether they have mastered the material or not. They have not often experienced success. This has led, in some, to poor attendance, low self-esteem and a general dislike for school. It is a constant challenge for me, as a teacher, to meet the needs of students in this classroom. Some are gifted in the areas of math, some theater, some are strictly visual learners, and some are at a reading level of a 3rd grader, as determined by standardized tests at the school at which I teach. More than 50% are learning disabled, approximately 25% are emotionally impaired, and all but 3-5 in both years of this study have Attention Deficit Disorder. I strive to make the teaching and therefore the learning meaningful for all of these students and to allow for personal success and satisfaction in the field of science.

Because these students are in special ed. mainstream classes, many of them have a learning disability of some type. These learning disabilities cause them to avoid certain styles of learning, and they make choices based on areas in which they have found success in the past. Some of

their disabilities are emotional. Most of the students are Attention Deficit labeled and do not take medication, whether it has been prescribed or not. This information has been passed on to me by the special education teacher working as a team teacher in this classroom. Official demographic statistics are on file in the office of this school.

In his research aforementioned, Professor Bloom found that the strategies of individualized instruction of the tutor and constant feedback of work done at the pace of the learner produced positive, successful results in which students learn more and better as measured by standardized tests. In this type of situation, a tutor provides verbal and written feedback according to the understanding of material and quiz scores. The tutor also provides a specific remediation procedure, if necessary, for the student. This is in contrast to classrooms where tests are given at the end of a unit, which provide only information for the teacher as to who in the class is doing well and who is not. (Bloom, 1968) The constant feedback and opportunity for the student to relearn what he did not master the first time provides the learner with an opportunity to succeed, as well as gaining important information on which to build other concepts. It is also the job of the teacher to not only facilitate the learning process for the student

learner, but to gear the opportunities to correct(students would be placed in the CORRECTIVE group to RELEARN) mistakes in a method according to the specific learning style of the individual, much as a one on one tutor would do. These students are then able to master the material by revisiting the material in another way. The Corrective is an activity that presents this material in another form. (Guskey, 1990) It is my finding in the investigation of multiple intelligences and learning styles, that when given a choice, a student will choose an option for learning or review that matches an activity at which they can be successful. Therefore, I have focused on work preferences because the preferences will lead to a feeling of success, and will also lead to motivation to complete and attend to work as well as mastery of the material. Hence, by taking into account the learning style of the student, success breeds success.(Gardner, 1995)

The activities for this study were in the logical/mathematical, visual/spatial, and intra-personal categories. In my study, the students did not feel comfortable presenting material orally. Rather, they felt more at ease with artistic expression, often discussing moral implications, and chose hands-on experiments in which they were the creators of the protocol, allowing them to put

their energies into the task at hand, rather than its presentation to others.

Highlights of research on the effects of Mastery Learning developed by Bloom (1974) and further investigated by Guskey and Gates (1986) are as follows;

1. Achievement results are overwhelmingly positive, as measured by test scores and student interview response.
2. Student retention is greater for those undergoing the mastery learning process in both 2-3 week, short term studies as well as 4 month, long term studies.
3. The time actually engaged in learning is greater in mastery learning classes as opposed to traditional classes. The time spent on correctives also decreases over time.
4. Students in mastery learning classes are more positive about learning and their confidence in their ability to learn is greater than others.
5. Teachers in these classes also have more positive attitudes, higher expectations for students, and more responsibility for the outcomes of their students.

The implications for instruction using a mandatory learning model are to provide choices for the student based on multiple intelligences and learning styles, provide individual support for the student, provide clear quality standards, and make connections to other topics and real-life issues. The study of Ecology is appropriate for this

type of instruction due to the hands-on practicality as well as the increased opportunity for hands-on labs in the environment. Furthermore, when focusing on the work preferences of my students, I can use variety and flexibility not only to reach all students, but to motivate them and make class more interesting.

The introduction to an Ecology text by Harmon Sutton (1973) begins with a quote by Dylan Thomas, author of A Child's Christmas in Wales, in which a science text was referred to as "a book that told me everything about the wasp, except WHY". In a world where mankind, specifically youth, fails to take responsibility for himself or herself, ecology and the study of the environment illustrate the effect mankind has on his surroundings. Ecological principles explain the relationships within the environment and therefore answer the WHY. Because of the location of the school in this study, a lack of high tech lab materials, and a need to make the information extremely practical and real, my choice of basing this study on Ecology and the environment seemed to be very appropriate for the teaching of mastery learning.

Furthermore, and most importantly, the study of Ecology was the first unit covered in the school year. I wanted to test out the Mastery Learning technique immediately and apply its benefits or failures to my

planning for the rest of the year. We begin with a study of interrelationships between various flora and fauna in the food web. I was able to provide a very hands-on approach to the study of interrelationships in this study because the time of year is appropriate for this and the environmental setting of the high school provides for a varied environment. The students were not limited by their immediate surroundings in their own back yard. There were plenty of natural relationships to study right around school: at the river, in the woods, or in the wetlands nearby. I wanted to use my research for the benefit of my students as close to the beginning of the school year as possible.

With this opportunity, I was able to incorporate a variety of activities and choices for activities that allowed me to examine the full potential of work preferences as a guide for teaching. This continued to be the situation for teaching the rest of the topics in the unit and enabled me as the facilitator to provide many options for students to learn.

The school setting is ideal for teaching ecology. It is located in an area surrounded by woods, a wetland is nearby, and the Flat River is within walking distance, even in a class period. This allowed me to incorporate activities such as water testing of the river and examination of food

chains and webs in the different types of environments. These ideas encouraged the student to combine different food chains, view the predator prey relationship in action and actually see man's effect on the environment. After the study of interrelationships, we were able to base our education on environmental concerns and finally on man's relationship to the environment: How does he/she affect it and what can he/she do to conserve it? Because local legislators were willing to come to our school, the students had a first hand interview with their State Representative and were able to ask their own questions about local environmental policies

Again, the setting of the school provided the location for the study of water and land pollution and we could directly measure soil samples for pollution and test the river for pollutants. The use of the Hach testing kit for bodies of water gave us real data with which to discuss the effect of pollutants on plants and animals in the river. We answered the questions " How much oxygen is present in the river? How much is needed by fish? How much carbon dioxide is produced by the animals living in the river? How is the relationship of fish to animals affected by pollutants? What are the sources of pollution in this particular river?" This brought our study back to the relationships in the environment, the effect man has on the environment and how

we can protect the environment. The work preferences that were most often chosen by students were a debate, a discussion in which the State Representative came to discuss current environmental concerns and the students were required to summarize the discussion, and a woodlot plot. The woodlot plot was an excellent way to culminate all of the activities in a variety of ways. For example, the students were required to observe a plot of land in a wooded area over 10 weeks. They were expected to document by camera and in written form (some students chose a video camera or tape recorder as their preference) any changes in habitat, plant and animal life and what affect man has had or will likely have in the next decade.

In my research of the topic of mastery learning and learning styles that affect the teacher's choice of both Enrichment and Corrective materials, it was evident that practicality and real-life situations as well as hands on activities are best for this type of education. These topics were chosen for this study because they are hands-on activities centered on the learning styles found to be work preferences in my class. These activities were appropriate for each individual, better enabling him/her to be motivated, and find interest and success in this unit. The personalization of material to be learned needs to be related to the student and based on something that the

student can visualize (Gardner, 1995). For example, if the student can actually test the Flat River for oxygen content and the consequent effect on fish, see the flow of ground water through a model, and talk directly to a local legislator about what is being done about pollutants in the ground water, the material is personalized and the effect is much greater. All children can learn when provided with conditions that are appropriate for their learning. (Gardner, 1995) Methods of Mastery Learning in the teaching of Ecology require a flexibility to individualize teaching and learning within the typical classroom setting (Guskey, 1981). Because the study of Ecology uses the environment as the laboratory and therefore provides many additional options for activities for both Enrichments and Correctives, there is no better way to bring the material into the hands of the students.

Using the outdoors as the laboratory for instruction is an integral part of this unit. According to Science Instruction in the Middle and Secondary Schools:

Laboratory work is a unique type of instruction that must be an integral part of science teaching. This type of activity involves students in firsthand experiences that permit them to participate in science as a way of thinking and as a way of investigating. Laboratory work provides students with concrete exemplars of science concepts and

principles, which can serve to reinforce course content. (Collette and Chiappetta, 1986)

Furthermore, students achieve higher scores on procedural tests when they perform the experiments themselves, as opposed to the traditional textbook style of teaching science. Students are also able to apply the problem solving skills learned in laboratory research to enhance their scientific knowledge. (Glasson, 1989)

I strongly feel that a study of the effect of pollutants on the community and the effect on food chains in this environment is an ideal situation for the material to be personalized to the student. This is important for the student, regardless of their learning difficulty or learning style, or even their socioeconomic status.

Our students will someday be making decisions about issues of water loss, increasing air pollution, acid rain, and other threats to our planet. Therefore, they need to be equipped with solutions and options for the proper management of our world. This and the hands on nature of the activities guarantee students' interest and comprehension while they learn the important scientific processing skills that apply to all sciences and discover the excitement of Ecology. (Galle, 1989)

IMPLEMENTATION OF UNIT

Background

For this study, I compared two large groups of students of approximately the same size. The first is the control group; students in my Life Science classes during the 1995-1996 school year, in which I used primarily traditional methods (see comparison of the two methods) of teaching the four to five weeks of material (Ecology). The second group is students of the same background in my classes during the school year 1996-1997, during which I used the Mastery Learning Technique. Both groups were about the same size, 25 students. (See Demographics, p. 1)

Overview of Research Changes:

In both test groups, I worked closely with a special education team teacher who assisted with the group work, division of the class into the two core groups, feedback on learning styles and evaluation.

The traditional unit studied during the school years of 1995, 1996 and 1996, 1997(control group) was a 4-5 week study of Ecology using text book-driven, traditional methods of instruction. The traditional style used primarily reading/ writing types of activities with few practical labs and the students were expected to move along at the same pace. They were instructed to read the text, organize materials into notes and perform some in-class labs. Due to the poor reading skills of the students (as indicated by standardized tests given by the team teachers) the students did not comprehend the material, if they read it at all. This, along with test scores that should have been better, brought about my desire to develop a different unit, one in which students had choices to motivate their learning and reflect their intelligence.

In the Mastery Learning course (1996, 1997) students were separated into groups according to their scores on frequent quizzes. The groups were those that had mastered the material with a minimum quiz score of 80% and could move on and those that had not yet mastered the material. These quizzes were both written and verbal. Students that did not master the material with a score of 80% or above were expected to relearn the material in a different way. This different way was indicated by choices that reflected their learning style, or the way they processed information. The

learning styles were categorized into 7 groups (see introduction). According to my experience, my students tended to choose activities with which they felt successful, reflecting their learning style. I chose to alter the material from the 1995-1996 school year by taking the text topics for the unit (below) and adding alternatives for different learning styles as well as adapting the current text and materials into a hands on approach, using the outdoor community as a laboratory. Key topics were the same for both traditional and mastery learning groups. Lesson ideas were altered to mastery learning style for the second year of the study. Differences between the units are indicated in Table 1.

Methods and Materials

The text ("Biology "; an Everyday Experience" by Kaskel, Hummer, Jr., Daniel Merrill Publishing Co. Columbus, Ohio 43216 Copyright 1988) was the basis of teaching information for both the test group (1996-1997) and the control group (1995-1996). This was not chosen by me, but is the required text for the teaching of this class. It is appropriate for this group of students because of its readability level as well as its many diagrams. On a computer readability test, the text scored at the sixth

grade reading level. It has short paragraphs, not much writing on each page, lots of graphs, charts and pictures and explains terms very well. However, the text does not focus on hands on activities, making the research for this study even more necessary, and drawing a greater distinction between the traditional, textbook class format and that of mastery learning.

In order to eliminate variables such as differences in core teaching material that might affect the outcome of this study, I used the classroom materials from the 1995-1996 school year as a basis for the materials for the 1996-1997 school year.

Methods of evaluation included the t test to compare the scores of the unit test for the 1995-1996 group and the 1996-1997 group and a formal interview of students conducted by the principal of the school. I also sent out a student questionnaire to both groups of students to determine the success felt by the student, self-respect, and general like or dislike of the class and material.

Table 1

COMPARISON OF KEY TOPICS

I. Topics

Mastery Learning Unit	**Traditional Unit**
A. Habitats (food chains, etc.)	same
B. Biomes	same
-ground water, current legislation, pollution	same

II. Lesson Ideas

Mastery Learning Unit **Traditional Unit**

A. Habitats

1. Nature hike organisms, put into habitat • Journal* • Set up aqua/terrariums from the river habitat	1. Brainstorm • journal • review
2. woodlot plot* 3. owl pellet lab*	2. owl pellet lab*

B. Biomes

• research types of biomes	• same
• visit to local botanical gardens	• same
• build as rainforest in*	• murals depicting artistic

school library, fill with flora and fauna typical of the biome, monitor climate	expression of biomes

C. Environmental issues

• water testing*	• groundwater model
• fish lab to examine* tolerance of fish in different water conditions	
• groundwater model*	• pollutant lab to test difficulty in removing pollutants from water
• visit from local* legislator/debate based on interview with various community members	• debate
• letter writing to legislator about local environmental concern	• same
• scrapbook/news article critique, summary	• same

*See " Laboratory and Field Exercises" section for a detailed description of these activities.

This unit covers the topics of Habitats, Biomes, and Environmental Issues. The Habitat section consists of a

study of food webs and interrelationships, such as commensalism and parasitism, as well as a discussion of abiotic versus biotic factors in the environment. This section includes a ten week study of a wooded area and the changes that occur over time.

The section on biomes compares and contrasts the different biomes and takes account of the water cycle and the Nitrogen cycle. This section includes construction and maintenance of a rainforest.

Environmental Issues studied are local and apply information learned in the previous sections to mankind's impact on the environment. Role-playing and a discussion with the State Representative are part of this section.

I was very excited about this study and was quite positively disposed about the results. Because of this, I was concerned about a personal bias toward the research data from the mastery learning process as compared to the "traditional group". Therefore, the principal and my team teacher helped in the evaluation, especially the verbal evaluation, so my bias toward the mastery learning process would not affect the results and skew the information.

In addition, any verbal evaluations were done by peers within the classroom, or by my team teachers or assistants in the classroom.

Summary and Evaluation of Laboratory and Field Exercises

As stated before, these activities were used as part of the mastery learning technique to appeal to the various modes of thinking and learning in the individual student, as well as to provide a motivation for learning the subject matter. A review of these non-traditional activities and my evaluation follows.

A. Journal: The students drew food chains and web diagrams depicting the concept links via verbal and written form. Information for journal entries was taken from several hikes to the areas near campus which included a woodlot, marsh and river. Over several days, the students would list in their journal the organisms seen on our hikes. The students were asked to do this on their own, while working on their woodlot plot project.(see below)

The journal was also used for the random question of the day, indicated in the overview. Because of the mastery learning process, the students in the mastery learning group were encouraged to choose different modes of communicating information in their journals. Some students chose a video camera, tape recorder, or drawings.

B. **Woodlot plot project**: This was an exciting, but time consuming project for all of us. It consisted of a ten week study of animal species, change in environment and interactions, habitat location, weather, flora and interrelationships of the chosen area, as well as man's impact on the environment. The students were required to keep their own weekly documentation of the changes, as well as take photos of the changes of one, consistent site. Some students took videos of the site, or used a tape recorder instead. This activity was excellent for providing choices to students, which is a key factor of the mastery learning process, especially for the deaf student and the blind student in this class.

C. **Owl pellet lab**: The students dissected owl pellets to examine the predator prey relationship in a real-life example. They were able to piece together bones to construct the skeleton of the prey. This is a very "hands on" type of activity appropriate for the mastery learning technique because it goes much farther than pictorially illustrating the relationships of organisms in the food chain. It was chosen by many students as a work preference.

D. **Water testing**: Using Hach test kits, we examined the Flat River for Ph, oxygen, and carbon dioxide content. We then

related this to amounts needed by producers and consumers and the health of the river. This activity was taken from lab work done at Kellogg Biological Station and is an excellent component of the mastery learning process because it provides for a variety of learning styles or work preferences. Those include hands on collection of data, analysis of the data, written response and oral discussion with the class.

E. **Fish lab**: Students examined the respiratory rate of fish in different types of water, by counting the opening and closing of the gills. They then discussed and applied information about carbon dioxide content, oxygen content, and findings of the water test at the river, continuing the mastery learning process of the previous lab.

F. **Pollutant lab**: In order to illustrate the longevity of pollutants in a body of water, we attempted to filter out representatives of local pollutants (coffee grounds, olive oil, etc.). We then discussed the cleanliness of water after attempting to naturally filter out the "pollutants". This became a major component of the mastery learning process because it provided for many additional activities such as interviews with the members of the community, role-playing,

a debate, actual participation in a town meeting and simulation of voting with the State Representative.

G. **Debate**: Students were asked to take on the roles of different members in a community and in a debate, represent these community members by lobbying for their point of view in relation to an environmental issue. This task dovetailed with many work preferences. Often, views were not those of the students and it was interesting to see them defend another point of view that was not their own. They acquired information by interviewing people in the community.

H. **Rainforest project**: After touring local botanical gardens, we were able to construct a living rainforest in a greenhouse in the library. We chose plants and animals appropriate for the climate. This particular activity was the cornerstone for my research on mastery learning. It was completely designed and carried out by students. The ideas were presented by students and all problem solving was done by students as well. A variety of work preference choices were available at all times. With this activity, I saw all of my students motivated and involved in the entire process, regardless of their prior motivation or success record in previous classes. The funding for this structure was donated by the District's Education Foundation and the project

brought much positive public approval. The structure was designed, built, and maintained by the collaborative efforts of my students, the math class, and the wood shop students.

I. Groundwater model: Using a model, we examined and discussed groundwater flow and the duration of pollutants in the water cycle. This was another opportunity to further investigate the effects of mankind on the community and to provide choices to students to learn the material, similar to the study of the river (see D-G) above.

Once again, the Enrichment Group has mastered the sub unit of material and, in the respect of time, need something interesting, yet motivating to work on while the other students (the Corrective Group) can catch up. The Corrective Group is made up of students that need extra or different activities to meet their level of learning and their type of intelligence (visual, spatial, etc.) in order to allow them to reach mastery.

To the Enrichment Group, I presented motivational materials (such as the maintenance of the rainforest and presentations to lower elementary students that pertain to the topic of study. For the Corrective Group, I devised activities and lessons that present the material in an alternative way, (thus the focus on learning styles) or review the material.

The students in both the test group and the control group, of the previous year, worked in groups as much as possible. I thought it important for these students to problem solve together and to share small successes in the group atmosphere. It was difficult during both years to keep all of the students on task at all times. However, that problem resolved itself when each group received a grade in three parts. The group members rated themselves as well as the other members of the group on time spent on task, reliability, and general knowledge about the project, and I rated them as I watched the development of the project. Group projects were the debate during both years, and the rainforest during the test years.

EVALUATION OF STUDENTS

In summary of my study of and experience with mastery learning, I found that it is important that I check my students for understanding by frequent quizzing (both written and oral) so I am able to give them constant feedback. I can also determine when they are ready to move on to the next subunit. Students scoring an 80% or above on these quizzes are placed in the Enrichment group and those scoring below an 80% are placed in the Corrective group. The quizzes determine into which of the two groups they are placed before moving on. These two groups engage in different activities as follows:

A. Enrichments provide interesting yet educational topics for students to study that have mastered the material. Students in this group have mastered the material, according to the quiz and they require some motivational work in order to maintain pace of all students. For example, the maintaining of a classroom rainforest is motivating, but not something that the students feel that they are penalized by doing "extra" work because they mastered the material.

B. Correctives provide students with the ability to master the material. These activities are based on the different learning styles as listed on page one. For example, a student that falls into the visual-spatial category, as indicated by choices in the areas of student success, may be able to revisit the predator-prey relationships by dissecting an owl pellet and putting together the bones of the rodent prey.

Correctives and Enrichments are designed to work in the typical classroom due to their flexibility for both individual and cooperative learning. They can be made up of activities chosen by students, according to areas in which they achieve success. They are geared to manageability and effectiveness and are tested in real classrooms, not laboratories. They are different from traditional methods of instruction, because they give students the opportunity to learn at their own pace and according to methods that suit their way of processing information. "(This) evidence indicates that although mastery learning strategies are not an educational cure-all, they can be an exceptionally effective tool that teachers can use to have a much more important influence on the learning and achievement of their students." (Guskey, 1980)

Another measure of success is attendance for this unit. The unit study took place over approximately five weeks.

Attendance is regularly a problem for these students in all classes. Since these students met during first or second hour, the least attended hours for this type of student, I thought attendance would be a good measure of interest, and therefore, improvement in the unit. Attendance in the class did increase compared to prior years as a result. A third and final method of evaluation is attitude and feeling of safety and well being on the part of the students. This was tested by regular, informal discussion with these students," eavesdropping " in on their conversations, class participation, and interviews of students by myself and the principal. Both test scores and attendance were compared between the two classes (Tables 1 and 2)

Table 2:

TEST SCORE AND ATTENDANCE DATA

Control Group	**Test Group**
1995/1996 Data	1996/1997 Data
2nd hour, 23 students	1st hour,25 students
Unit test score	
mean: 72%	mean: 80%
median: 71%	72%
mode: 75%	86%

t test data:

T score=(mean 1-mean 2)/Standard deviation of the mean

= 80-72/4.84

= 8 /4.84

= 1.65 (meaning, t test is close to one)

Standard error of the mean of the control group is 9.36. Standard error of the mean of the mastery learning group is Because the t test is close to one, null hypothesis is disregarded, although slightly. This indicates that there is a difference between the two groups, but it is not a great difference.

Table 3

Attendance

2.09 days absent (avg.)	1.16 days absent per 5 weeks

Overall, my students in the first hour Life Science Class did very well with the Mastery Learning Technique. Although the mean scores for both the test group and the control group were 72% and 80% which translates to a C and B average, respectively, I felt that the scores were not necessarily the only thing indicative of success. The score of 80%, in this case, is chosen as the threshold for mastery, and the test group attained this level.

According to all teachers involved, motivation and success did not appear to be present in 1995/1996. These students have been too " average", if that, and have felt apathetic about school. From talking with them, I have found that they do not typically feel that school applies to them, and especially science.

Not only were the students in the test group able to achieve the knowledge and information at their own pace, but they also were able to acquire a sense of success; very important to all students, but especially these. They needed a bit of flexibility in the schedule and they responded well to that. Since there was a real but not large difference in scores between the two groups, the overall attitude of the students and the tone of the classroom may be more important than the written scores themselves. One of the students commented: "She respects us as students and people, and her desire is to encourage us and help us to do well." Although

I do not have hard data on this type of measurement, my perception, my peers' perception, and the principal's perception was one of vast improvement in the overall tone of the classroom.

However, it is important to note that I went into this study with an expectation for immediate success. In my study of the mastery learning process, I was taken in and felt that it was infallible. I was also strongly encouraged about using the method of mastery learning in my teaching by my fellow teachers and the director of curriculum. I went to many conferences on the topic and was sold on the idea based on the seemingly huge success rate of the presenters. Everything I read about the topic was exciting and very positive. It seemed that using this technique with my lower learning capacity students could not go wrong. After all, these students need to be given their own time to succeed and to learn the material in their own way. Mastery learning for the study of Ecology seemed to be the answer for a lack of success that had been prevalent in this type of student for several years. However, my initial enthusiasm led me to overlook possible downfalls with the technique.

I failed to realize the effects of human nature. The major problem with my study was that the students realized at an early stage that they would have a second opportunity to be evaluated and therefore, they did not give their full

effort from the beginning. Because of my bias, I did not catch this at the beginning stages and was not able to prevent this from happening. They found a loophole in the process and eventually put little effort into succeeding. They were able to find out the information on which they would be tested by taking the first quiz. Then they could save themselves time or energy by preparing at a minimum, for only the portion of material that would be on a test. Many of the students then failed to see the whole picture.

I also found a discrepancy between my study and that of Guskey and Gates (1986). They both found an increase in memory as well as a decrease in the time required for correctives. My students increased the time on correctives because of the fact that this was the first time many of them put real energy and effort into learning the material.

The difference in overall score was only 8%. The test group had a mean score of 80% and the control group had a mean score of 72%. Although this is an increase and the testing group score of 80% does indicate mastery, it appears that the students worked only to the level of mastery, once again indicating their lack of consistent effort throughout the entire testing period. When we examine the t test data, we find that there is a t score of 1.65, thus indicating a slight difference, but the difference is shown only in the area of raw score, not knowledge of the material. The larger

the obtained value for t, the greater the chance of rejecting the null hypothesis. We reject the null hypothesis at .10, allowing us to conclude the slight difference in score between the two groups, but not an increase in knowledge of the students. A lack of knowledge is indicated by the lack of success on the initial quiz, represented by large numbers of students that had to participate in the corrective group.

The principal carried out informal interviews with the students, asking them how they felt about the instruction and how they felt about me as a teacher. I also sent out a student questionnaire, asking students to anonymously respond to issues of respect, success and organization of material (see appendix 3). The responses were overwhelmingly positive. The principal's interview collected responses such as "personal, exciting, energetic, helps ME as a student"

The survey collected responses such as

" You respect me and my needs."

" I feel I can do well with what you give me. My only excuse is myself."

" I do well with the choices you give us. It makes it fun to learn."

The hands on activities approach has long been my most effective way to teach science, due to the feeling of understanding I receive from my students when working on these types of activities. Coupled with the opportunity to use the environment as our laboratory, it was a success. The labs and activities,such as the woodlot plot and the rainforest were heralded by my peers and my mentors as excellent methods of teaching this unit. We were able to integrate additional subject matter by working with the math students and woodshop students on the construction of the rainforest.

Changes to be made to the project is to incorporate more mentoring within the classroom by encouraging all levels of students to take a chance at tutoring each other or even students from the district's elementary schools. Another issue is technology: I would like to feel more comfortable myself with bringing technology into the study of Ecology and I would like to be able to offer this as another " choice" or method of learning for my students. After all, they are more versed on the computer than I am and need to be able to practice and review their technology skills. I would like to do this by using interactive computer programs based on Biomes and Habitats and also to do more testing of water and soil in methods used at KBS:

sensors, to be used in the classroom and in exchange with other schools. The Internet will be a great advantage when researching legislative decisions on the environment and local concerns.

Furthermore, I would like to research ways to eliminate any chance of the students to take advantage of the program. Perhaps I could set it up in a fashion similar to Harberts and Nicolette,(1995) in which the entire unit is exposed to the students and it was to be completed within a certain time frame. Each individual piece is to be completed at the pace of the learner, and in a way that is suitable for him or her to learn the material best. This may eliminate the problem of the students not putting forth initial effort.

I would also like to allow students to brainstorm ways in which the material can be "enriched" or " corrected" and take care to respect their opinions and needs. Based on this program and the positive feedback I received by administrators, I believe it likely that I would have the support to acquire more funding and technology for the teaching of this unit. My curriculum supervisor is pleased with the results that he has seen in a variety of classroom settings with mastery learning and I have strong support from him. He has commented. " We need to ensure that every student here has the opportunity to learn science, by

whatever method suits him, and mastery learning seems to suit that need."

Most importantly, I feel that the student improvement in feeling a successful, sincere sense of responsibility for the stewardship of the environment, attaining a desire to be in school, and a feeling of safety within the classroom environment is invaluable. No test can measure these things, yet these are the key issues that affect true learning.

APPENDICES

Overview of Mastery Learning Unit

Vocabulary

A. Habitats(Ch. 30)
niche, biotic, abiotic, ecosystem, community, population, organism , producer, consumer, decomposer, mutualism, commensalism, parasitism, competition , predator, prey

B. Biomes (Ch. 31)

climate, succession, Nitrogen cycle, water cycle

C. Environmental Issues (Ch. 32)

pollution, legislation, ground water

Overview of Mastery Learning Unit

Day 1 Pretest in order to assess background knowledge. This may be done as a clinical interview.(See Appendix A)

Day 2 Introduction to Ecology

*start text Chapter 30, p.553

Walk in the woods adjacent to the school and down by the neighboring river.
The task is to document all organisms seen or heard. (Group or individual)
Assignment: formulate a web of relationships.

Day 3 Question of the day (5-10 min. at the beginning of the class to review information or to relate new information to prior knowledge. This activity also warms up the students' thinking)
"How do the populations of the community depend on each other?"

(see text for reference)

Compare assignments with other students. Discuss similarities and differences.

Using a mural, chalkboard, bulletin board, etc. devise a whole-group web.

While examining the whole group web, break it down into food chains.

Terms used today: population, community, food chain and food web, organism

Day 4 Assignment: What are possible producers and possible consumers in the area?

What is a decomposer? Give examples of each.

Day 5 Question of the day

"Make a food web with one consumer, three producers, and two decomposers. You must use a primary and a secondary consumer and an herbivore." Use your text for a resource, if necessary.

Woodlot plot discussion (See Appendix)

Discuss trip to the river to set up mini habitats

Discuss Mastery Learning Process with students. Explain method as well as reason for the change from the traditional method. Explain groupings, ask for suggestions, choices.

Review terms thus far, in verbal and picture form

Day 6 Evaluation/Quiz

Examine leaf collection examples to assist work on woodlot plot*

Examine keys

Do activity 30-2 " What are some parts of a food chain and a food web" (See Appendix)

Day 7 Question of the day: "Put our class food chain into an energy pyramid. Why are the bottom layers bigger than the top layers?" See your text for assistance.

Split class into two groups: Those who have mastered material and those who have not mastered material. Identify these groups as " Enrichment Group" (E) or as "Corrective Group" (C)

E. Set up terra/aquariums to be filled on field trips

OR choice of text reading, jigsaw notes with partner (each student is held responsible for the teaching of a portion of notes to the other members of their teacher chosen group.

C. Meet as a group, verbally go over terms, using various examples. Refer to class
food web.

OR choices (see above)

Day 8 Field Trip to the Flat River. Set up terra/aquarium.

In class assignment, to be given BEFORE going to the river.

Give an example of each of the terms we have studied thus far from the Flat River.

Homework assignment: do the same for your woodlot plot. Check progress on woodlot Plot. (This assignment due in 3 days)

Day 9 E. Maintain aquarium

C. Requiz to determine if relearning was successful.
Make class list of examples from assignment. Read sections 30:8-30:10.
Answer "Reflect and Review " p. 569. Study Table 30-2. Go over questions,
highlight examples from text. Use relationship examples (social)

Day 10 Chapter 31 begins on p. 573

Question of the day: "Describe the differences between the flora and fauna in a desert, tundra, and a temperate forest. What biome is Greenville found in?"

Read chapter silently. Describe an imaginary or visited place that corresponds to one of the key areas. (see map p. 583) in journal form.

Set up Activity 31-2 (text p. 581)

Day 11 Check activity. Answer questions.

Make murals of biomes. Start by brainstorming characteristics of different biomes.

Day 12 Jigsaw activity for groups of three. Prepare for quiz this week on jigsaw activity of the following information.

Group member A. Text section 31:1 Nitrogen Cycle

Group member B Text section 31:2,3 Water Cycle

Group member C Text section 31:5,6 Succession

Assignments due tomorrow, do activities on your group member's info.

Day 13 Correct each other's activities.

Finish murals

Day 14 Question of the day; "What are some characteristics of a rainforest biome? Where are they found in the world? "

. Discuss rainforest setup

Review day. Add any additional terms at this time in note form as well (niche, habitat, biotic, abiotic, ecosystem, competition, predator, prey)

Assignment for tomorrow; Find examples of these terms on field trip

Day 15 Field trip to Botanical Gardens

Day 16 Set up rainforest* in library

Day 17 Quiz

Correct in class, divide into new mastery learning groups, dependent upon latest scores.

Day 18 Group work: Split into group E or group C

E. Maintain aqua/terrariums

OR choices

C. Do 31-A,B,C,D as a group or individually

OR choices

Day 19 Go over all material from yesterday, correct

Work on rainforest in library. Continue set up " Any Content -Any Time" Activities, due tomorrow at the end of class
Requirement: all terms from the Habitat material (ch.30) and from the Biome material (ch.31) must be covered.

Day 20 Review individually or in small group tasks accomplished thus far

Day 21 Evaluation Day, using material "created" by students on Day 19
Quiz, made up of student derived questions from Day 19

Day 22 Discuss current community environmental issues, go to the Flat river for water testing
Assignment: newspaper critique and summary.(See Appendix)

Day 23 Visit from Legislator

Day 24 Discuss legislator's visit and current, local topics (newspaper articles, Flat river test)
Groundwater model

Day 25 Hand back evaluations and discuss, review

Fish lab*

Day 26 Question of the day " What is pollution? Give a local example and a suggestion to solve the problem" Compare and discuss (Use ch. 32 as a resource)
Prepare for role play activity tomorrow

Day 27 Role play. Take on the role of a local person to debate community environmental issues.
Assignment; write a letter to a legislator expressing a concern for our environment.

Day 28 Post test

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