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Embracing diversities in elementary schools : stepping outside the classroom

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Embracing Diversities in Elementary Schools: Stepping Outside the Traditional Classroom

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by

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Abstract

Teachers are currently challenged on how to include all students in one common and safe learning environment. Students don't come in cookie cutter patterns, but vary between cultures, genders, classes, race and ability. While children don't learn the same; a positive, common environment and learning atmosphere can contribute to learning of all children. Research shows that children that have difficulty in a traditional classroom setting can feel more comfortable in a less intense environment, like that outdoors. Many students with linguistic or physical barriers learn better actively doing rather than lectures, which gives great opportunity for science experimentations. These factors combine to present prime learning engagements with scientific viewpoints in a garden within the educational community.

Keywords: social inclusion, diversity, education, science, garden

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Back Story

I am the mother of three children. Each day as I pick them up from school I am asked if we can stay and play in the garden on their school grounds. It is their favorite place to spend free time! Even on weekends we find ourselves strolling to the garden, or collecting tadpoles from the Carmel River to deposit into the pond. It is a small area and a simple attraction. There is a clay oven used to bake pizzas at fundraising events. A small shed is within the gated area to keep tools for managing the garden. There are vegetables, herbs and an apple tree. There are recycling bins and a couple of picnic tables for learning or leisure activities. There is the beginning of a large sundial, which is currently a work in progress. There is also an area for two new vermicomposting bins.

Each week every classroom on campus has the opportunity to visit the garden. I'm not entirely sure what they do there, but I know they have studied bugs, learned about compost, recycling, gardening, and even made applesauce from the apples grown there. Various projects are also performed in the garden. The garden is used for science based instruction. Besides time spent with their class, students are able to visit the garden during their recess or lunch periods.

From the little exposure I have had to the garden, I have realized what a chore the maintenance is. Besides the garden teacher instructing the students and formulating projects, they are expected to weed, water and perform other regular maintenance to the structure. I have seen the garden teacher working tirelessly on weekends in support of the upkeep. And yet, in the four years that I have visited the area, I find that the same projects that were once started still are not complete. I see

that the fence on one side is unstable. The sundial so cleverly fashioned is still incomplete. I am sure that there are many other projects in the making that are not seen to the casual wanderer. On many occasions I have thought that I would like to help. This year a new garden teacher was hired and several volunteers have found themselves useful in the establishment and aid of the garden.

I would like to incorporate the garden at Carmel River School into my capstone as a combined research and project base. Recently a grant was awarded to the garden for the establishment of two vermicomposting bins. I would like to assist in the research of how to make them, what is necessary for them to function optimally in this environment and then setting them up. Since excessive waste is becoming a larger environmental problem, I will research the environmental benefits of vermicomosting. I would like to incorporate the children in to the project by setting up a system that would allow them to contribute compost materials and then informing them of the project. I will make an informational lesson plan that can be presented in the classroom. I will also find alternative vermicompost ideas and plans the teachers may use in their curriculum. The result of the vermicomposting will then be utilized in the garden.

Nature of the Problem

In the speculation of becoming a teacher, it is natural for a person to consider all of their fears and challenges and in turn, seek a solution in preparation. Looking back as a student, I recall being bored and lacking intellectual stimulation. I remember teachers focusing on students who needed extra help and being frustrated, thinking that teachers should be able teach all children simultaneously. Later in life, as a parent of a busy boy, I think about how I would teach children who have difficulty focusing. During my service learning, I saw firsthand the struggles that teachers face with linguistic disconnections from students. In response to these feelings, I want to consider challenges that teachers currently face and support a project that can encompass all children, regardless of diversities.

One challenged posed to teachers comes from the increase in immigration. California has the highest concentration of English Language Learners (ELLs) in the United States, accounting for 40% of children K-12 (Gandara, Maxwell-Jolly, & Driscoll, 2005). These students have diverse academic, language and social needs as well as various experiences with school. They have a variety of cultural norms and traditions. With such variables, a positive learning experience ideally should come from a well educated and prepared teacher. However, many teachers are not prepared to participate in the recommended (and disputed) bilingual education. Nor have most teachers had training to instruct culturally and linguistically diverse (CLD) students (O'Hara, & Pritchard, 2008). Within a study by Gandora, Maxwell-Jolly and Driscoll, recommendations were made to help the teachers. Included in the results, was a development and compilation of resources within a specific subject to aid

teachers. While the teacher maintains the responsibility in the classroom—clear, concise and well researched materials can aid their preparation.

Besides cultural differences, some children have physical disabilities that present unique challenges to teachers. Physical disabilities can include hearing or visual difficulty. ADHD and ADD are also becoming more common in children. An estimated 8-17% of children display symptoms of ADHD (Tymms, & Merrell, 2006). Children with physical disabilities, especially minor, are increasingly being placed in the mainstream classroom. Often qualified teachers are unavailable and underprepared instructors are hired and expected to perform at the same levels. These teachers are ill-equipped for such challenges and the children struggle. As a result, children with such disabilities are diagnosed with negative developmental outcomes, such as being antisocial and achieving lower grades.

With such diverse groups of children it is necessary to adapt curriculum in such a way that all students are challenged and embraced. This will allow them to develop socially and intellectually. Teachers can benefit by projects and programs that allow for the growth of all children—the 'A' student as well as the struggling student, the ELL, the CLD, the disabled. Although the task is daunting, with research and creativity, programs can be established and implemented that welcome all children.

Interventions

An Australia school population mimics the diversity found in California, with 40% being migrants or the children of migrants (Tangen & Fielding-Barnsley 2007). The school found success in their instruction by releasing the struggling students from the intensity of the traditional classroom and providing a safe, interesting and less threatening area of instruction—the school garden. Through upkeep of the garden, students were able to gain a better sense of belonging in the school community, develop confidence and then have a great learning experience in both the garden and the classroom in all areas of study, including language and literary development, mathematics and areas of social and environmental studies (Tangen & Fielding-Barnsley 2007). As a side benefit, the nutrition habits of the students also changed in a positive manner. They were able to participate hands-on with the environment. In a conclusion of the study, the authors noted that for potential of school gardens to be met, that all children needed the opportunity to utilize the space. Teacher aid is also necessary to help the students make connections between learning in the traditional classroom and the outside learning area. This was just one of several studies that I reviewed in my research to find a project that would encompass all children from multiple backgrounds and with various capabilities, to develop a program that would be beneficial to all students and help the teachers meet their challenges of outreach and inclusion.

Another study was conducted in Florida with a focus group of primarily Haitian-Americans. A curriculum program was developed to build students' science

knowledge while also helping them acquire English usage. During this study the teachers noted time restraints. Although they wanted to do research on more effective programs or ways of teaching, they were limited by time and resources. The teachers admitted be challenged in the area of science especially, not having taken college coursework in the subject. Within the trial district, children speak 107 languages—90% being ELLs. The schools engaged in a program that focused on improving teachers' science understanding and helped them realize how activities, such as experiments, discussions and writing, can improve children's awareness in science as well as English (Cavanagh 2008). Learning without textbooks forces communication. Small-group activities help building relationships and establish social connections. Science can be taught as a universal language, learning by conducting experiments, and it provides a strong vehicle for English instruction. Science promotes natural inquiry rather than textbooks or lectures in a way that is interactive and promotes personal connections.

After piloting a garden atmosphere in Canada, Janet E. Dyment and Anne C. Bell state, 'Our garden is colour blind, inclusive and warm' (2008). They conducted a study primarily focusing on how to "promote social inclusion with respect to gender, class, race and ability." They developed a system which allowed students to participate in the creation and upkeep of the grounds. Several student benefits emerged: "increased play opportunities; healthier, safer and less hostile outdoor environments; increased learning opportunities; increased connections to the natural environment; improved academic performance (Dyment & Bell 2008). Teachers also noted that they had less classroom management issues and they appreciated

the unique opportunity for curriculum development that encompassed the projects the children were participating. From a social perspective, educators observed “an improvement in students’ abilities to collaborate on projects with others, to function democratically, to communicate with others, to give care to self and others and to practice civility towards others (Dyment & Bell 2008). The study showed that all children felt inclusion from the project. The garden produced a less intense and level playing ground for all students, but especially those that felt isolated on the basis of gender, class, race and ability. Since the study, over 500 additional schools in Canada have mirrored the instruction in hopes of reaping similar benefits.

In the Southwest, a group of drop out students attempted to turn the desert into a garden. Instructors found that the students were able to reengage into the community. The project involved the creation of a traditional Native American Yaqui garden. An emphasis of the program incorporates preparation, action and reflection activities which present opportunities for personal, social and intellectual growth in addition to civic responsibility and career exploration (Sandler 1995). The study focused on 13 former dropouts. At the conclusion of the project, all 13 completed the academic goals set by the project. Equally as important, the students’ attitudes changed as they felt included in the community. They developed a stronger sense of self worth and a stronger desire to succeed.

An empirical study was conducted in a Norwegian primary school in the classroom of a seasoned teacher, Ann, who had two particularly challenging students in her 22 pupils. While there were not any conclusive labels for the children, they were exceptionally unruly and unfocused. The question in study was:

How does a Norwegian primary school teacher deal with inclusive education in her ordinary classroom activities? (Moen, 2008). The study found themes for success including participation in various activities, smooth and flexible transitions, individual and mutual relationship with the children and having common pleasant experiences. Positive characteristics shown during the study are membership, mastery, togetherness, involvement and learning (Moen, 2008). These themes can be found common in all of the studies reviewed.

Even though children are different, there are common links between then. All children need to feel safe and comfortable to actively participate in a learning environment. They need to possess ownership and feel a self mastery when they have achieved their goals. Group collaboration helps involvement and learning between peers and contributes to their social well-being, which relates to their learning capabilities.

Community Partner

My ideas of the project came about because of the love my children have for the garden at Carmel River School. The garden is funded by the PTA and is run by a PT staff member, Claire Philips. She is new to the garden, hired earlier this year and a former local elementary school teacher. Ms. Philips has a goal to redesign the garden into a stronger learning environment that the children can engage in and she is working tirelessly to make changes, alongside volunteer help. My assistance is most needed in researching vermicomposting and then helping to integrate what I've researched in a practicum in the garden as well as implementing a process in which the students can participate. Child participation will include me devising a lesson plan to be presented in each classroom, helping them learn about the bins, worms and how they can be cared for. I will also help develop a routine in which the students can collect 'waste' for the livelihood of the project. Ms. Philips appreciates me taking control of the project, using the funds granted as well as helping facilitate teacher/student participation. I will gain knowledge of the subject as well as experience in organizing the project and then developing a lesson plan to teach it—with the possibility of presenting it in all of the classrooms after the initial pilot of the program.

Significance

In my studies I have learned the value of an integrated learning environment, balancing hands on activities with learning. This project epitomizes that capability for all of the students at Carmel River School. It is a project for the entire school that can be built upon to whatever level the facility desires. The framework is to establish the bins, teach the students about them and then let the students take ownership in helping the worms thrive in an ideal environment. This project can embrace the NSE standards at any grade level. It is not just learning about something, but actually doing it. If teachers like the idea, they can create a similar worm culture in their own classroom. If they are not fond of the idea, the children are still exposed to the product and learning about it during their designated time spent in the garden, with the option of spending their recesses there. The ideas and learning opportunities are for all children of all backgrounds. Another educator, Kathy Lyons, who created a similar project commented, “I told the children that they didn’t have to touch the worms but by the end of the class they had them on their noses.” Later she added that being able to feed the worms healthy ‘waste’ the children notably chose to bring healthier foods—just so they could share. This project is ideal and embracing of collaborative and integrated learning.

With the pilot of this project, it will give teachers an additional resource that they can integrate into the classrooms immediately. Students are to be instructed and then left to maintain the project, taking ownership and responsibility of the worms. In maintaining a successful vermicompost center, they can take pride in

their success. They can embrace being part of the school community. The project can represent a baseline for additional science experiments, for those teachers who feel less secure teaching depth in the subject. Ideally, as proven in other similar instillations, it can promote social inclusion which is reflective upon learning.

Assessment Tool

A valuable part of my project will be research of vermicomposting. The research will be evaluated by the garden teacher, Ms. Philips prior to the creation. Upon her satisfaction, the project will continue. A lesson plan will then be developed and presented, with the start of the new garden project. As we will be piloting the project with a single 3rd grade class, I will interview the teacher after the initial lesson for feedback. I will also interview some of the children to see what knowledge they acquired, and if the material was presented in such a way that they understood red worms well enough to maintain their livelihood. A completion of the deliverables will mark the assessment. After completion, I will again interview Ms. Philips to get additional feedback. Ultimately, a thriving and ideal worm environment that is maintained by the students will be the ultimate goal.

Project Details, Deliverables, Timeline

Project Details

My intentions in this project are to support the garden teacher at Carmel River School in establishing a vermicomposting system. I will research the most ideal method of doing this and explicit instructions on how to create a vermicomposting environment (see Appendix). A system will be created according to the research, including the actual bins and procedures for maintenance. I will then create a lesson plan to teach students about the system and how they can be part of the learning environment. The lesson plans will be able to be duplicated to all the classrooms at a later date. Additional corresponding lesson plans will also be available to the faculty if the wish to integrate the learning into their classroom, or create their own system (see Appendix).

Deliverables

My first deliverable will be research on how to make and maintain vermicomposting bins (see Appendix). The system will then be built according to the specs researched, the grant funded and the actual funds provided. Instructions will be made for the students on how to care for the worms. A lesson plan will be established, tailored to the pilot classroom, which can later be altered for various grade levels. I will also accumulate other lesson and resource ideas that the teachers may use as additional option.

Timeline

- September: Develop a community partner and assess their needs for the project. Begin research.
- October: Conduct research as to what should be done, how to do it and successful examples of it being done.
- November: Build the physical vermicomposting system. Outline what information the students will need to care for the system. Research an effective lesson plan.
- December: Present a lesson plan to one classroom as the pilot to the program. Allow them to help in the creation of the bins, the placement of the worms and first feeding. Provide the garden instructors with the lesson plan and supplemental lesson plans for faculty use.

Results Summary

After the completion of the project I conducted an interview with the garden teacher, Ms. Philips. She was pleased with the research that had been conducted. The vermicomposting bins seemed to be productive. While she did not observe the lesson presentation, she worked with the children at the conclusion. She assessed them as knowledgeable of the worms and respectful. They were aware what waste could be shared and the procedures for sharing. Ms. Philips felt comfortable in the system that had been established in the feeding of the worms. We did discuss that the same few children were feeding the worms and have decided to conduct a follow up lesson plan in the classroom to get additional feedback from the children. Since they have all contributed waste and are now aware of the project, there may be additional questions or concerns that can be addressed, and there are always additional learning opportunities.

At the close of the lesson presentation to the 3rd grade class I talked with the children about what they had learned. They were competent in knowledge about the worms and the ideal habitat and feeding conditions. I felt comfortable leaving the worms in their care.

Ms. Lebel was the generous 3rd grade teacher who offered to be part of the pilot program. She was pleased with the lesson presentation and was fascinated herself. She thought the kids were well engaged and informed. I had brought in flashcards of various foods which she thought was helpful in creating a mental picture. I also brought in food and asked the kids to help me sort out the waste—

orange peelings, apple cores, celery leaves. We then took the waste to the garden where we explored the worms' anatomy with a magnifying glass and then shared with them their first meal. Ms. Lebel found it helpful that we engaged in the same practice the children would be demonstrating each day during their lunch hour. She has requested a follow up lesson.

I think that hands-on activities allow deeper thoughts and manipulations and that this project embraced that. As I was researching, I focused more about the bins, but when I was teaching, the children were more aware of the worms. I would like to include more background information of the worms, as that is what is so intriguing to them—not just the feeding system. The kids appreciated a discussion and question answer forum more than a lecture type and were thoroughly engaged. In future presentations, I would like to allow them more time for exploration and discovery.

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Appendix

Background Research

Carmel River School PTA has already been awarded a grant to create a vermicomposting system. A vermicomposting system uses livestock—worms—to "turn organic wastes into very high quality compost (Addison)." This compost will be used in the garden for planting and cultivation. There are three basic types of systems: windrows, wedge systems, bins and beds (Sherman, 2002). The nature of this research is to establish what kind of system is best, what vermicomposting entails and then to present established case studies of its effectiveness.

Vermicomposting is not a new perspective. Records indicate that Charles Darwin was likely the first person to conduct an in depth study on earthworms (Melear, & Lunsford, 2007). Since then, various harvesting methods have been tried to reap the benefits of their castings. The first type of system is windrows. This method requires a lot of land or a large building—which the school cannot provide. The second system, wedges, uses less space. Materials are added into a pile and the livestock naturally migrates up, reducing the need to separate the worms from the compost. This method is effective but would be messy in such a contained and functioning environment. The last method would be most ideal or the school, which is to create beds or bins. This method uses less space. It is also more comfortable for the worms, since they can burrow closer or further to the

surface dependent on the temperature (Sherman, 2002). After research, space has been designated for two bins within the garden area.

Composting bins may be built of plastic or untreated wood, but wood composes better results. To help regulate temperature and moisture levels, they should be covered. Vermicomposting consists of placing a mixture of organic materials within a bin and allowing the livestock to harvest it. The livestock referred to are worms. There are a few different kinds of worms that may work in vermicomposting but the ideal worm for California temperatures is the *Eisenia fetida* because it is an epigeic organism. This means that "it may be most commonly found living and feeding among leaf litter (Melear, & Lunsford, 2007)." Ideal conditions for this species include a dark and damp (not wet) environment with good air circulation and temperatures between 55 and 77 degrees Fahrenheit.

Several studies indicate the effective results of vermicomposting. One study, conducted in the Philippines beginning the the late 1970s, now numbers more than 10,000 producers today. Tests given in the Philippines resulted in higher produce yields—1.3-2.6 times—and higher nutrition content—5.8 times higher—than that of regular compost (Guerrero, 2005). Another study, conducted by the University of Wales and Ohio State University, also showed that the casts excreted by the worms increased plant growth rates, although seemed more specific to the species than generalized (Roberts, Edwards, Edwards-Jones, & Jones, 2007). It is not necessarily the manure that is beneficial; it is the micro-organisms living within it. Since the casts have been inside the worms any pathogenic bacteria has been killed. The casts "contain five times more nitrogen, seven times more phosphorus,

and 11 times more potassium than ordinary soil…and the casts are also rich in humic acids [which] have a perfect PH balance (Addison).

After researching the subject, I've found that bins are most ideal given the spatial arrangements. Conclusions have also been made as to what worm is best suited for this climate and that the local weather will satisfy the necessary living conditions. Research has shown the benefits of vermicomposting which will be useful and practical for growth within the garden.

Practicum

Funding is already in place for a vermicomposting project. An area of the garden has been designated. Ideal conditions suggested that the bins be built of untreated and clean wood, to absorb moisture and keep moisture content at optimal levels while allowing ventilation. Addison suggests brushing the interior of the box with vegetable oil or linseed oil to avoid too much absorption.

The size of the box is suggested to be between 8-16 inches high, being careful since "materials tend to pack down in taller bins, which result in areas with reduced oxygen. It should have a lid to contend with the elements as well as to keep out flies and rodents. It must also have holes (a quarter in. or smaller) in the bottom for ventilation and drainage.

To begin, bedding must be made. The bedding should consist of a variety of materials such as shredded cardboard, shredded newspaper, shredded paper, commercial worm bedding, shredded fall leaves, shredded fall plants, chopped straw and compost. Adding a handful of soil or sand will help the worms grind up the food. Ground limestone or wood ash can also be good in the mixture. To prepare the bedding, soak the materials and then ring them out to dry. Let them sit for a few days so they are not too moist, but can be broken down easily.

To start the project one pound of worms should be used (purchased at a bait store or nursery). Depending on ideal conditions, worms can multiply to anywhere from 35lbs-1,000lbs in a year (Addison). Overpopulation is not a concern though, as long as the worms are all getting enough to eat. If there is not enough to eat within the bins, worms will start to die. If there is too much to eat, flies will lurk.

The worms may be fed every few days or even once a week. Food should be buried in the bin in a circular pattern, giving the food a chance to be composted. The worms will migrate to the fresh food. The livestock may be fed the following: vegetable scraps, fruit peelings, leftover pasta, bread and grains, tea bags, coffee grounds and filters, eggshells. It is best to maintain a healthy Carbon to Nitrogen Ratio by balancing the green matter (food) and brown matter (bedding) by about 2:1.

There are different ways to harvest the vermicompost and should be harvested every 3-6 months. It should sit for a few days before use and can be preserved up to a year. It is best blended with compost and not applied adjacent to stems. Depending on what is being grown, the vermicompost can be blended into the top inch of the soil or up to six inches on top.

Elizabeth Pateen and Kathy Lyons are the “Worm Ladies” to the elementary students they teach. Awarded a grant by the U.S. Department of Agriculture’s Food and Consumer Service they were able to teach students about vermicomposting. They suggest letting classrooms maintain their own bin, while teaching children to care for the worms. To begin their instruction, they ask the students to make an ‘Earthworm Caretaker Contract.’ They then teach the children what they should know in maintaining the bins. The students are taught what they can feed the worms, including awareness of maintaining a proper PH ratio between green and brown matter. For a project like this, they suggest advising the custodial staff also. With the project base as the foundation, other curricula can then be experimented with, including writing, art, math and music. To help the other faculty, they conducted teacher training sessions, made kits and gave corresponding curriculum ideas (Farrell, 1997).

Melear and Lunsford also have experimented with vermicompost projects in the classroom. They have developed a long-term unit, beginning with the creation of the bins as a hands-on learning activity. They give multiple lesson suggestions, such as: research changes in food materials and castings, study the worm cycle, behavioral responses of the worms to environmental variables, ecological roles of the worm (*E. fetida*), research papers ideas, assessment by communication (written or verbal), laboratory notebooks, reflective journal entries, maintaining checklists, small group discussions, collaboration in a learning community.

A combination of inquiry-based and theme-driven lessons promote a healthy scientific atmosphere in a classroom while maintaining NSE standards.

Establishing worm bins are just the first step in promoting a learning community at Carmel River School. While I've listed practicum instructions, possibilities are endless if the faculty wishes to integrate the learning into the classroom. The staff can fully embrace the ideas or simply allow the children to wander into the garden during breaks, but the resources will be available along with two great examples that they may follow.

Lesson Plan

Instructional Planning Activities

Grade/Level : 3

Subject Area: Science

Concept:

Students will learn about red worms, what they eat and necessary conditions for an ideal habitat. They will learn about vermicomposting, increase their knowledge about benefits of composting and the reduction of food waste.

State Academic Content Standards

Science, Grade 3

Life Sciences | 3 Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

Objective

Students will learn about earthworms and vermicomposting. They will also learn how to manage an earthworm composting bin by doing hands-on activities demonstrating proper procedures and management techniques.

Assessment

At the close of the lesson, students will be able to work in groups to mix and match cards that show foods that are healthy and unhealthy for the earthworm to eat. Using the jigsaw method, students will teach other students the proper methods of handling and maintaining a composting bin.

Through informal questions and answers like; raise your hand if you can tell me how long the earthworm lives. Or, turn to your table partner and explain 3 foods the earthworms do not eat. Or, when I mention a food, give me a thumbs up or down if they can or cannot eat it.

After the lesson presentation, there will be an open question/answer forum.

This will be achieved through the group matching activity. This activity will allow students with special needs to speak, hear and use tactile senses to stay engaged.

Vocabulary/Language Skills

Students will get exposure and reinforcement of words like; nitrogen, carbon, larvae, organic material, castings and micro-bacteria.

Classroom Management

The children will start at their desks with me in the front of the class. I will show them the anatomy of an earthworm and explain the basic parts. At the close of the lecture portion, I will split them into four groups. Some will peel oranges, some sort celery, some core apples and some shred newspaper.

Models of Instruction

Direct instruction will be used to teach the students about the earthworm, its eating habit and composting.

Materials

An empty 3 gallon container. Laminated cards that show good and bad foods to give the worms. Worms for observation and a magnifying glass for each child.

Instructional Procedures

Composting is the decomposition of plant remains and other once-living materials to make an earthy, dark, crumbly substance that is excellent for adding to houseplants or enriching garden soil. The best way to recycle yard and kitchen wastes is to put food and other once-living matter into a compost bin to decompose. It should be possible to recycle up to 30% of garbage that is usually thrown away. When these materials decompose, they break down into an organic matter that is rich in nutrients and nitrogen. The nutrients in the compost are added back to the soil as a means of recycling and replacing the nitrogen that was previously used up by plants' growth. Compost is natural fertilizer that adds nutrients to the soil and loosens the structure of the soil.

Worms help to speed up the decomposition process. They are constantly burrowing and tunneling in the earth. As they go, they gobble up dirt and debris, bits of dead leaves, insects, and other decaying plant and animal matter. They grind this mixture into mush and break down the debris. Their *castings* (a fancy name for manure) are rich with nutrients that are added to the natural decomposition taking place in the compost bin.

- Red worms stay at home, under normal conditions. They will not crawl away if adequate food, aeration and moisture are provided for them.
- Mature red worms living under favorable conditions, may produce 4 to 10 egg capsules every seven days.
- The egg capsules incubate in 14 to 21 days. Each egg capsule produces from 2 to 20 worms with an estimated average of 4.
- Newly hatched red worms will reach breeding age in 60 to 90 days. They develop a muscular band called a clitellum around its body near the head signifying it is mature enough to breed.
- Red worms continue to grow until they are approximately 9 months old. The normal length of a healthy red worm is about 3 – 3 ½ inches.
- Red worms have a lifespan of several years with estimates of more than five years.
- Red worms feed from beneath after they become familiar with their new environment.

- Red worms eat the bacteria that breaks the organic material down. They do not actually eat “food”. When you see them feeding on the top layer, be sure to give them more food to process.
- Waste you feed may consist of almost any organic material and red worms will convert it to fertile dirt faster when it is supplied in smaller pieces.
- Remember, the finer the food is when it goes into the bin, the quicker it will be processed and the finer your final vermicompost will be when they are finished.

Breathing, Smelling and Hearing

- Red worms have no eyes, ears or lungs.
- They breathe through their skin.
- The air which is present between soil and food particles is diffused through their moist skin into a complex network of blood vessels.
- The mucus they excrete helps keep their skin moist.
- They have a complex nervous system, which enables them to sense light, food, acid conditions, vibrations and heat.

Eating

- A red worm has no teeth so it cannot chew.
- Instead, a red worm uses a small pad of flesh that sticks out above its mouth to consume the bacteria that breaks down the food.
- When the worm is eating the pad stretches out and scoops the bacteria up, pushing it into its mouth.

- Muscles then pass the "food" down through its gizzard where tiny, hard pieces of grit rub together and grind the food into smaller particles.
- The "food" leaves the gizzard and passes into the worm's digestive tract. There it is broken down into even smaller particles.
- These nutritious particles are absorbed into the worm's bloodstream, which is pumped around the worm's body by five pairs of hearts.
- The remaining particles are passed out of the worm; this is called castings.

The importance of aeration

- Aeration is just a big word that means “air in the soil.” Does anyone know why air is so important in the worm compost bin?
- Air is very important for the microorganisms and the worms in the soil to survive.
- The worms take water in through their skin and that is how they breathe.
- Air allows passage of water, which is necessary for the worms to live.
- A microorganism is an organism that can be viewed only with a microscope. An example of a microorganism is bacteria. When the microorganisms are working in the soil, they need a certain amount of air to break down the different parts of the compost. If there isn’t enough air for the microorganisms to work, the compost bin will have a very bad smell, sort of like rotten eggs.
- Air is also important to make the soil “porous,” which means having many holes.
- The holes are important for water to move and keep the worms moist. To make the soil more porous, it is important to turn or stir the compost every so

often. For a large compost bin, such as an outdoor compost pile or bin, a pitchfork can be used.

- For a smaller bin, like our worm bin, a small three-pronged garden tool will work best. Gloved hands will also work in the smaller bins.

The importance of water in a compost bin

- Compost bins of any type need moisture. Worms and microorganisms need water to survive just like we do. They need it to move around and break down organic matter. The bedding and compost should be as moist as a well-wrung sponge. It cannot be too wet or too dry because the microorganisms and worms would not survive. The worms need water to breathe.

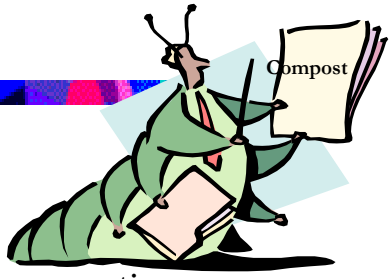
While worms can eat a variety of foods, ours will be 'vegan,' eating only the remains of fruits and vegetables. They cannot eat banana peels.

Activity

Show flashcards of foods and let the children decide if they can or cannot eat it. When the students understand the diet of the worm, break them into groups and prepare 'waste.' For example, peel oranges, core apples or sort leaves from celery. Prepare waste in a container to present in the garden. Once in the garden, have a station available for each student with dirt and worms for observation, including a magnifying glass. After exploration, feed the worms the 'waste' by demonstration and then duplication.

*Additional Supplemental Material available: http://www.csgn.org/page.php?id=43

Compost Lesson



Goals

Students will...

- Learn basic facts about composting with worms, called vermicomposting.
- Compost at home.
- Increase their awareness of the environmental benefits of composting.
- Reduce food waste.

Objectives

Students will...

- Identify basic concepts about composting.
- Demonstrate self-confidence in preparing a salad and dessert.
- Cooperate in food and worm activities.
- Participate in composting activities.

Lesson Activities

Introduce composting
    Background information on composting
    Lessons from the Farm
Set up compost bin
Make salad and dessert recipes
    (Form groups of 4 to 6 students)
Eat
Wrap-up
    Distribute copies of recipes and challenge sheets to students
Clean-up

Other Compost Activities

Compost fact sheet, Writing ideas, Worm anatomy sheet

Background Information on Composting

Composting is…

Composting is the decomposition of plant remains and other once-living materials to make an earthy, dark, crumbly substance that is excellent for adding to houseplants or enriching garden soil. The best way to recycle yard and kitchen wastes is to put food and other once-living matter into a compost bin to decompose. It should be possible to recycle up to 30% of garbage that is usually thrown away. When these materials decompose, they break down into an organic matter that is rich in nutrients and nitrogen. The nutrients in the compost are added back to the soil as a means of recycling and replacing the nitrogen that was previously used up by plants' growth. Compost is natural fertilizer that adds nutrients to the soil and loosens the structure of the soil. There are two types of composting – indoor and outdoor. Outdoor composting uses heat, bacteria and microorganisms to break down composted ingredients. Indoor composting, or vermicomposting, can be done in a bin and uses worms, bacteria and microorganisms, and should not generate heat.

Worms help with the composting process by…

Worms help to speed up the decomposition process. They are constantly burrowing and tunneling in the earth. As they go, they gobble up dirt and debris, bits of dead leaves, insects, and other decaying plant and animal matter. They grind this mixture into mush and break down the debris. Their *castings* (a fancy name for manure) are rich with nutrients that are added to the natural decomposition taking place in the compost bin.

A composting bin includes…

A compost bin includes two types of ingredients—brown and green. The "brown" ingredients are good sources of *carbon* and the "green" ingredients are good sources of *nitrogen*. You need a balance of these two elements in order for the compost pile to work and break down the different materials.

"Brown" ingredients include:

coffee filters	cotton/wool/silk scraps
corncobs	sawdust
dried grass clippings	tea bags
hay or straw	wood chips
dead leaves	wood ash
paper	pine needles

Background Information continued

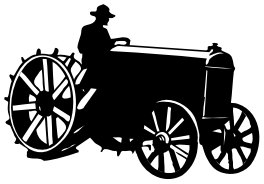
"Green" ingredients include:

- algae
- bone meal
- coffee grounds
- eggshells
- feathers
- flowers
- fruit and fruit peels
- fresh grass clippings
- hair
- manure
- seaweed
- tea leaves
- vegetable scraps and peelings
- weeds

Materials NOT to put in a compost pile**:

- Meat
- Fish
- Fats
- Dairy products

**These materials should not be in a compost pile because they are more likely to produce strong odors and attract animals.



Composting is a process that breaks down organic waste materials like the food scraps that are left over from cooking and makes them into soil and humus, thus completing the growth cycle.

Compost can also be made from parts of the vegetables and other foods that are discarded before eating and from lawn clippings and any weeds that are in your garden. Also, you can use the manure from pet cages or from farm animals.

How do you do this? It is really very simple.

You need to have the right balance of green and brown materials. Green materials are such things as discarded plant and food materials. Brown materials can range from dry plant materials like hay, to materials such as sawdust and paper. These are mixed in a pile or bin in your backyard. Occasionally you must turn and mix these materials and make sure they are damp enough. Eventually you will see them beginning to become "soil." This compost may then be mixed with your garden soil to grow new plants. The same thing happens in worm bins where you feed kitchen food scraps to worms. The worms break down the scraps into rich vermicompost that can be added to your garden soil or to potted plants to help make them grow.

Good luck with your lessons and on learning how to compost!

Materials and Preparation

Food needed for making a fresh layered salad (for 4 groups)
4 heads lettuce or other greens
4 cups diced celery
4 cups diced red onion
4 small bags frozen peas –thawed
1/2 cup of sugar
1 quart light sour cream, light mayonnaise, nonfat, or low-fat plain yogurt
4 cups vegetarian or regular bacon bits
4 cups grated parmesan or cheddar cheese
4 cups crunchy dried chow mein noodles (to represent worms)

Materials needed (for 4 groups)
4 large glass bowls
4 small bowls
4 cutting boards
4 knives
4 sets measuring cups and spoons
Cleaning towel, napkins
Compost bucket
4 large spoons
Copy of recipes for each student
Copy of compost fact sheet for each student
Copy of writing ideas sheet for each student
Copy of challenge sheet for each student

Each station should have the following:

Food
1 head lettuce or other greens
1 cup diced celery
1 cup diced red onion
1 small bag frozen peas –thawed
2 tablespoons of sugar
1 cup light sour cream, light mayonnaise, nonfat, or low-fat plain yogurt
1 cup vegetarian or regular bacon bits
1 cup grated parmesan or cheddar cheese
1 cup crunchy dried chow mein noodles (to represent worms)

Materials
1 large glass bowl
1 small bowl
Cutting board
Knife
Measuring cups and spoons
Cleaning towel, napkins
Compost bucket
1 large spoon
Copy of recipes for each student

Use Maine ingredients when available.

Classroom Recipe for Fresh Layered Salad

Ingredients:

1 head lettuce or other greens
1 cup diced celery
1 cup diced red onion
1 small bag frozen peas –thawed
2 tablespoons of sugar
1 cup light sour cream, light mayonnaise, nonfat, or low-fat plain yogurt
1 cup vegetarian or regular bacon bits
1 cup grated parmesan or cheddar cheese
1 cup crunchy dried chow mein noodles (to represent worms)

Use Maine ingredients whenever possible.

Student Cooking Activities

Note: This recipe needs to be made a couple of hours before serving.
Mix sugar and sour cream (or yogurt or mayonnaise) together. Make a layer of each ingredient in order listed, reminding students how layers are important for composting (although you wouldn't use animal products such as sour cream, cheese or bacon bits in real compost pile). Using a glass bowl will help show various layers. Top with sprinkles of crumbled bacon. Let set in refrigerator 2-3 hours. Do not let sit overnight. Add chow mein noodles just before serving.

Materials and Preparation continued

Food needed for dirt dessert (for 4 groups)
4 pkgs. chocolate sandwich cookies
1/2 gal milk
4 pkg. chocolate flavor instant pudding mix (package for 4 servings)
4 tubs whipped topping, thawed (8oz tub)
64 gummy worms
4 bottles green food coloring
4 7oz bags shredded coconut

Materials needed (for 4 groups)

4 large bowls
8 wooden spoons
4 sets dry measuring cups
4 trays
Plastic spoons
4 small bowls
4 plastic bags
4 rolling pins
4 wire whisks
Cleaning towels, napkins
4 rubber spatulas
4 sets measuring spoons
32 9oz plastic cups

Each station should have the following:

Food
1 pkg. chocolate sandwich cookies
1 pint milk
1 pkg. chocolate flavor instant pudding mix
1 tub whipped topping, thawed (8 oz)
16 gummy worms
1 bottle green food coloring
1 7oz bag shredded coconut

Materials

1 large bowl
2 wooden spoons
1 set dry measuring cups
1 tray
Plastic spoons
1 small bowl
1 plastic bag
1 rolling pin
1 wire whisk
Cleaning towel
1 rubber spatula
Measuring spoons
Copy of recipe
8 9oz plastic cup

Use Maine ingredients when possible.

Classroom Recipe for Dirt Dessert

Ingredients:*

1 package (16 oz.) chocolate sandwich cookies
1 pint cold milk
1 package (4-serving size) chocolate flavor instant pudding and pie filling
1 tub (8 oz.) whipped topping, thawed
8 (9 oz.) plastic cups
16 gummy worms
1 7 oz. bag shredded coconut (3.5 oz. needed)
1 bottle green food coloring

*** Choose Maine ingredients when possible.**

Student Activities

Dirt: Place chocolate cookies in plastic bag, seal and crush with rolling pin.
Add 2 cups milk to large bowl. Add pudding mix.
Beat pudding mix for 2 minutes with wire whisk. Let stand 5 minutes.
Fold in the whipped topping.
Grass: Place coconut in bowl and add a few drops of green food coloring. Mix well.
Place 2 Tbs. crushed cookies in the bottom of each cup.
Place 1 gummy worm in each cup.
Add 1/2 cup pudding to each cup.
Repeat steps until cup is full.
Top with coconut grass.

Yield: 6 servings

Date_____ Name _____

Compost Fact Sheet

1. What is composting?

2. What are the two types of composting?

3. How do worms help make compost?

4. What are “brown” ingredients good sources of? Give an example of a brown ingredient.

5. What are “green” ingredients good sources of? Give an example of a green ingredient.

1. What did you like or dislike about this lesson?

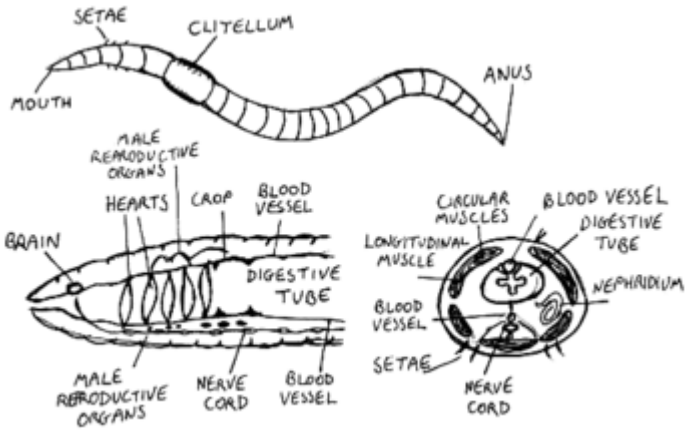
2. Write a story that includes at least three of the facts from the mixed compost fact sheet.

3. Think of some questions and write a letter to a local farmer.

4. Prepare the dirt dessert recipe for your family or friends. What did they think? Did they like it? Were they surprised?

5. Write a story from the worm's point of view telling what it is like living in a compost bin.

Worm Anatomy



Mouth- where food enters the body

Pharynx- moistens the food and pumps food into the esophagus

Esophagus- a pathway for passing food from the pharynx to the crop

Crop- temporary storage place for food

Gizzard- grinds food into tiny pieces

Intestine- where food is digested and the nutrients are absorbed into blood

Heart(s)- beats and pumps blood into the blood vessels

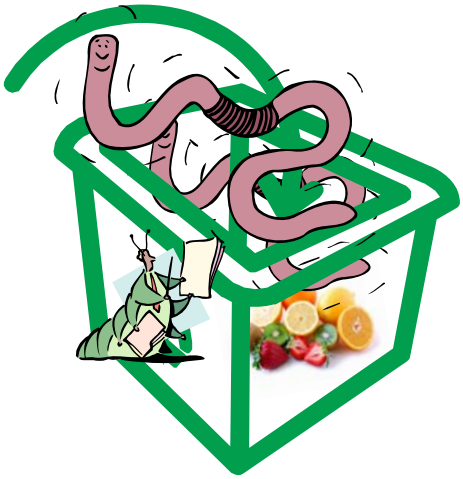
Blood vessel(s)- carries the blood throughout the body of the worm

Nerve cord- extends the length of the worm

How to Start a Worm Composting Bin

Materials:

Bin:	Plastic tote bin	1/4”-1/2” drill bit
	Burlap bag	Bricks (4)
	Drill	Large plastic tray
Bedding:	Shredded newspaper strips	Topsoil
Worms:	See reference list to order worms	



Set Up:

1. Take the plastic bin and, using the drill, make a few holes in the bottom. This is important for aeration and drainage of the vermicompost.

2. To create the bedding, take shredded newspaper and dampen with water.

3. Fill three quarters of the bin with this bedding (should be the consistency of a well-wrung sponge).

4. Take two or three handfuls of topsoil to mix in with the newspaper combination. This is important because it helps introduce microorganisms.

5. Now introduce the worms to the bin: place them in the bin without the lid so that they become accustomed to their new environment, ideally in the morning to give them plenty of time to establish their new burrows.

6. Once they have established themselves (they all should have burrowed throughout the bin—if they have crawled up on the sides of the bin then they may be disoriented), (check activity chart on page 37) you can add the food.

7. Feed green material, especially green vegetables and other table scraps, excluding fruit, dairy, fatty foods, meat and poultry.

8. When you add the food (see background information in the compost lesson), make sure it is buried in the newspaper mix and not placed on top.

9. Ideally, the bedding should be changed every two months or so and the same steps must be taken to provide a new, healthy environment for the worms.

Please note that this is only one method for constructing a bin. It is strongly recommended that you use the references listed on the following page to supplement these instructions or to purchase a pre-assembled bin.

A detailed description on how to establish your own worm composting bin can be obtained from the following websites:

Flowerfield Enterprises www.wormwoman.com
10332 Shaver Road
Kalamazoo, MI 49002

The original "Worm Woman," the late Mary Appelhof, created Flowerfield Enterprises. Her website contains a wealth of information regarding worms, bins, and the how to's of composting, as well as the books and videos listed below.

Resources for Worms and Composting

Worms Eat My Garbage: How to Set Up and Maintain a Worm Composting Bin
By Mary Appelhof
$12.95

The Worm Book: The Complete Guide to Worms in Your Garden
By Loren Nancarrow and Janet Logan Taylor
$9.56

The Worm Café, Mid-Scale Vermicomposting of Lunchroom Wastes
By Binet Payne
$25.95

Worms Eat Our Garbage: Classroom Activities for a Better Environment
By Mary Appelhof, Mary Frances Fenton, Barbara Loss Harris, and Daniel L. Dindal
$22.95

The World of Worms
By Dorothy Hinshaw Patent

Healthy Foods From Healthy Soils
By Elizabeth Patten and Kathy Lyons.
One of your Maine-ly Nutrition program choices, this "teacher's guide … allows children to experience the cycle of gardening, eating food, and composting."
www.tilburyhouse.com/Children%27s%20Frames/child_health_fr.html

How to Use the Mini-Lessons with the Program

The topic of composting is a very important subject to introduce to young people. The issue of environmental conservation is becoming more prevalent in our society as concern for our planet escalates. Composting is a simple way to cut down on waste and return key ingredients to the earth to improve soil quality.

The compost lesson is thorough and informative and allows for tremendous interaction between the students and nature. This unit is recommended as the primary unit in order to establish a foundation that can be continued and applied through the rest of the program.

To complement the compost lesson, we have designed twelve hands-on “mini-lessons” on composting and vermicomposting, one for each of the twelve food lessons. Composting is a methodical process that requires time before the final result is seen. Once the compost lesson is presented, note that each food lesson has a segment expanding on one of the various concepts of composting. The mini-lessons follow a recommended order based on building the fundamentals of the composting process. They are arranged so that you may select the food lessons and use the sequential interactive mini-lessons to develop students' knowledge of composting.

Mini-lesson 1: Formation of Soil

The natural process of composting has been going on since the beginning of time. As plants die, worms and bacteria help break down plants into decomposed matter called *compost.* This once-living plant material mixes with inorganic (non-living) matter such as minerals from rocks. Over time rocks are changed into smaller particles by wind, water, ice, and the roots of plants as they move in the earth. All this breaking down of material results in the gradual formation of soil. Good soil is very rich in nutrients and nitrogen needed for plants to be healthy.

Activity:

Fill a lunch bag with pieces of waste, demonstrating lunch leftovers (bread crumbs, apple cores, a plastic spoon and napkin).
Show the students the items in the bag, asking which ones are organic (i.e., once-living, not to be confused with foods which were raised naturally without synthetic chemicals/pesticides) and which are not.
Ask the students which items they think the worms will eat.
Pick two of the items and bury them in the worm bed to see if they will decompose.
Write the name of each food item on a label and attach the label to a dowel or straw.
Mark each spot with the dowel or straw where the items are buried.
Check each item after 2 weeks to see if it has decomposed.
Check again at 3 weeks, and again at 1 month.

Decomposed Items

2 weeks	
3 weeks	
1 month	

Mini-lesson 2: The importance of aeration

Aeration is just a big word that means "air in the soil." Does anyone know why air is so important in the worm compost bin?
Air is very important for the microorganisms and the worms in the soil to survive. The worms take water in through their skin and that is how they breathe.

Air allows passage of water, which is necessary for the worms to live.
A microorganism is an organism that can be viewed only with a microscope. An example of a microorganism is bacteria. When the microorganisms are working in the soil, they need a certain amount of air to break down the different parts of the compost. If there isn't enough air for the microorganisms to work, the compost bin will have a very bad smell, sort of like rotten eggs.
Air is also important to make the soil "porous," which means having many holes. The holes are important for water to move and keep the worms moist. To make the soil more porous, it is important to turn or stir the compost every so often. For a large compost bin, such as an outdoor compost pile or bin, a pitchfork can be used. For a smaller bin, like our worm bin, a small three-pronged garden tool will work best. Gloved hands will also work in the smaller bins.

Activity:

Have students demonstrate how to turn the compost in the worm bin by taking turns with the garden tool. Gently turn the compost so that the bottom material is brought to the top, being careful not to harm the worms.
Have students show and explain what would happen if the compost is not aerated. Prepare two mini-compost jars and show over time how the compost is affected when the contents of only one jar are aerated while the other is not. This can also be demonstrated by aerating only one side of the compost bin.

Mini-lesson 3: The Importance of Carbon, Nitrogen and Oxygen in Composting

When the organic material (the food) is breaking down in the compost, this is called decomposition and carbon is released. **Carbon** is the most common component in organic matter. The bacteria and the fungi in the compost digest or "oxidize" carbon for energy. (Remind students that the word "organic" also refers to foods grown without the use of chemical fertilizers, pesticides, or drugs.)

There are five factors that encourage the process of decomposition:

Warm temperatures (up to a maximum of 85°F-90°F)
Adequate moisture – when squeezed, the bedding(or finished vermicompost) should feel like a well-wrung sponge
Adequate aeration
Microorganisms
Decomposers (such as worms)

Nitrogen

In the compost bin, bacteria and fungi will ingest nitrogen for protein synthesis. When organic matter is removed from the compost bin and mixed with the soil around houseplants or around plants in the garden, the plants get nitrogen from the organic matter. The plant material that decomposes is very rich in nitrogen. A perfect balance of nitrogen is important because too little will cause the leaves of plants to turn brown rather than green, and too much will kill the plant. A small amount of vermicompost, however, is much milder than a synthetic fertilizer product.

Oxygen

Oxygen is incorporated into the compost bin through aeration, which is done by stirring or turning the material in the bin. Oxygen is needed for the aerobic bacteria to survive and work in a compost bin to break down the food material.

Activity:

Materials: 2 flower pots or jars
6-8 beans (for example, dried pea or kidney beans)

Procedure:
Soak six to eight beans overnight in water.
Fill one flowerpot or jar with ordinary potting soil from your lawn or garden.
Fill the second flowerpot or jar with a half-and-half mix of the same type of soil and some finished compost or vermicompost.
Plant a few beans in each pot.

Place them in a warm, sunny place.
Water the pots as needed and see what happens.
This is a good way to demonstrate how recycling food waste can be turned into natural compost, as opposed to purchasing potting soils that contain chemical fertilizers.

Mini-lesson 4: The importance of water in a compost bin

Compost bins of any type need moisture. Worms and microorganisms need water to survive just like we do. They need it to move around and break down organic matter. The bedding and compost should be as moist as a well-wrung sponge. It cannot be too wet or too dry because the microorganisms and worms would not survive. The worms need water to breathe.

Activity:

Have students soak a medium-sized sponge in water and wring it out until no water comes from the sponge.
Test the moisture content of the worm bin by taking a handful of the bedding/compost and comparing with the wetness to the sponge. It should be about the same. If water runs through your fingers when you squeeze the compost/bedding, then there is too much water in the bin and you should add more "brown" ingredients (newspaper, pine needles, etc.). If it crumbles in your hand, it is too dry and you should spray water into the bin to moisten the contents.
Test the moisture content of the compost bin with a hydrometer (can be purchased at any hardware or garden store).
Why do worms need moisture?
Why do we need moisture?
Worms need moisture in order to take in oxygen to breathe. We need moisture to maintain all the cells in our bodies.
Have students hold their noses and cover their mouths [briefly] so that they can't breathe. This is how the worms feel if they don't have water or moisture in the compost – they can't breathe!

Mini-lesson 5: The importance of darkness in a worm bin

Light is not needed in a compost bin; in fact, worms do not like light. Worms can tell the difference between light and dark because they have cells in the front part of their bodies that are sensitive to light. Since they are so sensitive to light, they will burrow deeper into the bin bedding to avoid it. They are more sensitive to some kinds of light than others. Worms much prefer to be in the dark.

Activity:

Cover the bottom of a container with paper towels.
Using a water mister, dampen the paper towels evenly, being careful not to soak them.
Put some worms in the center of the container. Remember to mist them occasionally as you continue.
Cover half of the container with a cardboard sheet.
Shine a flashlight on the open side of the container and note what the worms do.
Return the worms to their compost bin.
Cover the flashlight lens with blue colored cellophane, secured with a rubber band.
Repeat the experiment using a new group of worms and note how they react.
Repeat again using red colored cellophane.

Worms shy away from white light, while their sensors do not pick up red light, so there should be no reaction. Worms are extra sensitive to blue light, and should shy away immediately.

Mini-lesson 6: The importance of earthworms in a compost bin

Worms have many different and important roles in the composting process. About one pound of worms is needed for every pound of waste per week that you put into the bin. Worms speed up the process that naturally occurs as organic matter is broken down in your compost bin. As the worms tunnel, they make burrows that allow air to get down into the bedding and help improve the water flow. The major function of the worm is to eat the material put into the bin. They also eat the decaying debris in the compost bin that might otherwise smell like rotten eggs. The worm has a body part called a gizzard, which can grind up big particles of food. After the food is ground up, the worms cast out new organic matter that is packed with nutrients that are very good for your plants and gardens. These digested vermicastings make up vermicompost.

Worms have no lungs. They take their oxygen directly through the skin, either from air or water. The oxygen they take in goes directly into their bloodstream, but their skin must stay moist in order for oxygen to pass through.

Worm Anatomy

Prostomium: Snout or mouth where food enters the body
Pharynx: Moistens the food and pumps food into the esophagus
Esophagus: A pathway for passing food from the pharynx to the crop
Crop: Temporary storage place for food
Gizzard: Grinds food into tiny pieces
Intestine: Where food is digested and the nutrients are absorbed into blood
Heart: Beats and pumps blood into the blood vessels
Blood vessel(s): Carries the blood throughout the body of the worm
Nerve cord: Extends the length of the worm
Setae: Stiff bristle-like extensions that help the worm to move forward
Clitellum: Also called the saddle. When the worms reproduce, this slides up over the worm's body and enclosed the sperm and eggs, forming a cocoon from which the baby worms will hatch.

Activity:

Label the worm diagram with the appropriate labels.
Ask questions such as: How do they move without legs? How do they breathe without any lungs? How do they sense light and dark without any eyes? How are they similar to us and how are they different?

Mini-lesson 7: Other bugs in a compost bin

There are other important animals in a compost bin besides worms and bacteria. These animals are called invertebrates: organisms without a backbone or spine. These invertebrates are also called consumers because they eat different materials in the bin or outdoor pile to help break down the matter put into it. Some animals serve as food for other animals. A food web (or cycle) is made up of many food chains, and shows how a community of organisms is interrelated. One food chain example is when an insect is eaten by a small bird, which is in turn eaten by a larger bird. This important cycle is repeated everywhere in nature.

Activity:

Demonstrate the food web by assigning students a particular animal and determining who will eat it and so on up the chain.

Mini-lesson 8: Proper pH of the soil in the compost bin

An important part of keeping the compost healthy is to keep it at the proper pH, which means having the right balance of acid and base in the soil. For example, lemon is a very acidic food. Baking soda is a very basic food. The two different components of the compost bin (the green and the brown ingredients) help to balance the pH. It is important for the compost to be in a certain range of pH so that the plants can absorb the nutrients from the composted material. The pH of a bin should be between 5.5 – 8.5.

Activity:

To test the pH of the compost bin:
Take one cup of compost and mix it with 2 cups water in a container or jar.
Let the soil settle for about 5 minutes.
Gently strain the water out of the container or jar.
Take one pH hydrion strip (litmus paper) and dip it in the water (for only a second).
Match the color of the hydrion strip to the key on the side of the bottle to determine the pH of the soil.
Test different food items to determine if they are acidic or basic.

Mini-lesson 9: Temperature of the compost

In a worm bin that is working properly with enough water and oxygen, the temperature should be between 40°F and 90°F. Worms are most active at room temperature and survive well in this temperature range. A higher temperature shows that more organic matter is decomposing. In an outdoor bin, the temperature might be much higher or lower, but because it doesn't depend on worms, this is acceptable. Microorganisms can still function at a range of temperatures to break down the matter in the pile or outdoor bin. During Maine winters, the outdoor pile or bin may be "resting" until warmer weather arrives.

Activity:

Insert a candy thermometer into the center of the compost bin and determine the temperature. Take weekly readings and compare temperatures. Make adjustments if needed to keep the bin within acceptable ranges.

Week	Temperature
Week 1	
Week 2	
Week 3	
Week 4	
Week 5	
Week 6	
Week 7	
Week 8	
Week 9	
Week 10	
Week 11	
Week 12	

Mini-lesson 10: Uses of composted material

Compost can be used in many ways to improve the soil and overall health of your house and garden plants. It can also be used to fertilize the lawn as well as shrubs, bushes, and flowerbeds. Compost tea can be sprayed onto your plants or used to water them. Composted material can be placed around plants in the garden or in the pots with your houseplants.

Activity:

Making compost tea:
Place some composted material into an old pillowcase and soak the pillowcase in a bucket of water until the water becomes tea-colored.
Put the tea into a watering can to water plants in the house and in the garden.
(Your plants will thank you for this.)

Mini-lesson 11: Harvesting Worms

After the worms have lived in their bedding for 2-3 months, you will notice that the bedding material has changed to a healthy looking “soil” or humus, and even though the worms have been fed a considerable amount, the level of the bedding will have visibly dropped. To encourage the healthy reproduction of the worms, now is the time to harvest the bin’s contents.
Harvest the finished vermicompost when the first bin is full and there are no recognizable food scraps.

Activity:

Place new bedding material in a second bin and place the bin directly on the compost surface of the first bin.
Bury your food scraps in the bedding of the second bin.
In one to two months, most of the worms will have moved to the second bin through the holes in the bottom of the top bin, in search of food.
The first bin will contain (virtually) worm-free vermicompost. Use this around plants in your garden or your houseplants.

Mini-lesson 12: Troubleshooting

Occasionally you may encounter some problems with your worm bin. It is important to check the worm bin every time you feed the worms. By doing this, you will be able to recognize any problems and correct them before they get out of hand.

Activity:

Correct any problems using this chart.

Problem	Probable Cause	Solution
Worms are dying or crawling up the side of the bin to escape	• Too wet • Too dry • Bedding is used up	• Add more bedding • Moisten the bedding • Harvest the bin
Bin smells bad	• Not enough air • Too much food • Too wet	• Leave lid off or drill more ventilation holes • Do not feed for 1-2 weeks • Add more bedding
Fruit flies	• Exposed food, especially fruit waste	• Bury food in bedding • Put open bin outdoors for several hours to kill the fruit fly larvae

Compost Quiz

1) T F A nutrient helps a plant grow strong.

2) T F Both brown and green material is needed to make compost.

3) T F Composting has happened since the beginning of time.

4) T F Inorganic matter is living material.

5) T F Nitrogen is the most common component in organic matter.

6) T F Carbon helps keep the leaves of plants a nice, bright green.

7) T F Oxygen is added into the compost bin through aeration.

8) T F Aeration helps to make the soil very porous.

9) T F Earthworms can be very important in the composting process.

10) T F Worms do not help to improve water flow into the compost.

11) T F Anaerobic bacteria need air to work in the compost.

12) T F Bacteria need food and water just like we do to live.

13) T F Invertebrates are animals with a backbone.

14) T F The only animals in a compost pile are worms.

15) T F "Brown" and "green" ingredients help keep proper pH of soil.

16) T F The compost moisture should feel like a well-wrung sponge.

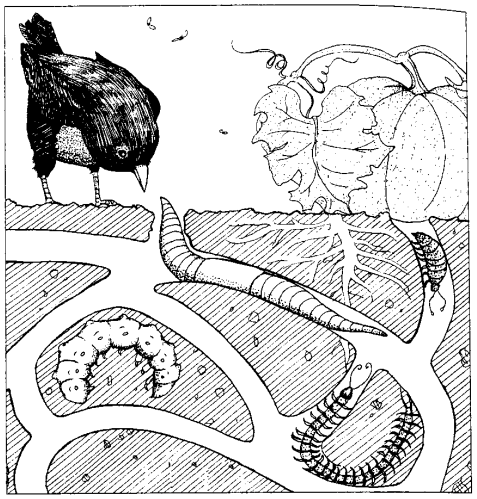
17) T F The lower the temperature of the compost, the more organic matter is decomposing in the compost pile.

18) Write an example of a "green" ingredient _____

19) Write an example of a "brown" ingredient _____

(Answer Key on page 208-209)

Compost Creatures and Friends[1]



Play Worm Bin Bingo and make a Worm Bin Field Guide

Recommended Grades: K–6

- **Science**
- **Language and Visual Arts**

Goals

Learn about the inhabitants of the compost ecosystem and appreciate what is involved in creating healthy soils. Students research, locate, and identify the inhabitants of the world of decomposition ("creepy crawlies").

Key Points

- There is more to a worm bin than meets the eye; the closer you look, the more you will see.
- Every critter in the worm bin plays an important role in the composting ecosystem.
- Believe it or not, the largest number of organisms in vermicompost are too small to see without a microscope! Billions of bacteria, fungi, and actinomycetes are an "invisible" workforce in soils and compost piles.

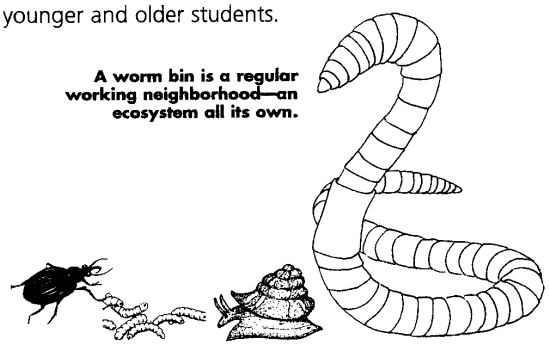
Background

They're not officially invited guests, but after two to four months, a variety of compost creatures can be found scurrying and crawling around in what you thought was solely a home for composting worms. This is usually good news; for the most part, the uninvited guests are toiling away for their room and board—and aiding the worms in breaking down some of the hardest stuff in the process.

[1] Worm Bin Bingo Game inspired by and adapted with permission from *The Microcosmos Curriculum Guide to Exploring Microbial Space,* edited by Douglas Zook, Kendall Hunt, 1994.

Who arrives in your bin will vary from bin to bin and how they get there seems like a bit of a mystery. However, bacteria and fungi are ever-present in our air, and foods contain organisms that naturally start the decaying process over time. If you added a handful of soil to the bin as recommended, it probably contained some eggs or larva of some of these unsolicited guests. Others may have just followed their noses, so to speak. The organisms you find in the bin can also be found in soils rich in organic matter and in outdoor compost piles. These creatures are basically decomposers or are the predators of decomposers!

While the other decomposer organisms may outnumber the earthworms in the bin, the worms are still essential. It is their digestion of organic material that creates the nutrient-rich worm castings that plants and gardeners love. *Note:* The activities in this lesson could be divided into projects for younger and older students.



A worm bin is a regular working neighborhood—an ecosystem all its own.

What You'll Need

For the Worm Bin Field Guide: books on soil and compost organisms; drawing paper; pencils; microscope if available (ask high school science teacher).
For Worm Bin Bingo: large plastic containers (recycled from home) or trays; magnifying lenses; copies of the Worm Bin Field Guide and Compost Creature Bingo Cards (see Getting Ready); worm compost, outdoor compost, or organic-rich soil.
Optional: prizes for bingo.

Teacher Tip

For younger students, just taking time to search for and identify compost inhabitants from illustrations is probably enough. For older students, this could take several class periods, depending on your goals.

Getting Ready

For the **Bingo Game**: Duplicate the Worm Bin Bingo Cards for handouts.
For the **Worm Bin Field Guide**: List living organisms the students have noticed in the worm bin so far—redworms, cocoons, etc. Add names of potential worm bin visitors from Meet Some Compost Creatures on page 167. Divide class into small groups and distribute worm bin inhabitant names evenly among the research groups. They are to create identification pages for the assigned organisms. (Be sure they include an illustration and four important facts for each organism.) When their research is complete, compile the pages together in a Worm Bin Field Guide. Make copies for each group if desired. This Field Guide will be helpful in the bingo game to follow. You may want to enlist a parent or older student helpers for these activities.

How to Do It

Begin by explaining the rules of the game.

- Groups work together finding compost organisms. (They can use the Worm Bin Field Guides made earlier for help.) Explain the rules/procedure. When they find a compost creature, they must identify it by name and record an observation about it—what it was doing, how it looked, where it was, etc. For each organism they identify and observe, they must receive verification from the teacher. If the teacher is satisfied with their description, and their observation, they can "X" out that organism's square on the bingo game or draw it in a blank square and "X" it out, and then start looking for another.
- A group gets "bingo" when four blocks, vertically, horizontally, or diagonally are "X"ed out.
- All searching must stop when the teacher gives a pre-determined signal—for additional instructions, to ask questions, or to share a special observation in the classroom.

Next, hand out bingo cards, trays with compost samples, magnifying lenses, and Worm Bin Field Guides, if available. Allow groups to start. Monitor success among the groups. Allow one sample swap of compost from the bin per team if locating creatures is slow.

Then, stop when either a certain amount of time has passed, or there's a bingo. Clean up.

Classroom Conversations

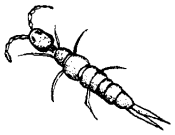
- Ask the groups to describe what they observed in the worm bin. Did each group find the same things? Discuss how these organisms got into the worm bin.
- Encourage students or groups to report any interesting behavior or sights during their investigations.
- Ask them if they played the game in a month or so from now, would anything be different?

Want to Do More?

- Dig into some leaf litter or an outdoor compost pile in search of the same compost creatures. Play the bingo game as you locate specific creatures. For indoor exploration, take a shovelful of soil from outdoors and place it on a white sheet to look for creatures.
- Have older students teach younger kids about compost creatures using the Worm Bin Field Guide they created.
- Write a story from the point of view of one of the organisms found in the compost.
- Arrange the organisms according to where they fit in the compost food web.

Meet Some Compost Creatures

With the exception of the centipede and spider, all the organisms listed below are decomposers. They help break down vegetable matter.



Springtails are numerous in nature and are impressive in how they hop. However, they are so tiny ($^1/_{16}$ of an inch—small enough to fit on the head of a pin) that their huge leaps don't look like much to us. Only if they appear in large numbers in the bin will their jumping draw some attention.

Spiders like dark places and they like to eat, so it's not uncommon to find one or two making themselves at home and dining on the tiny insect life living in your bin.

Sow bugs are related to pill bugs. They also have armored plates but do not roll up into a ball like the pill bug does.

Mites are related to ticks but most of the species in the bin are vegetarians. You may find them in large numbers on the surface, but you'll have to look closely. They have eight legs and are quite tiny.

Millipedes don't really have one thousand feet but some may have as many as one hundred. Fossils indicate they appeared on earth roughly 400 million years ago—long before dinosaurs walked the earth. Like pill bugs, they curl into balls when disturbed.

Pill bugs have ten pairs of legs, making them "isopods" and they have flattened plates that make them look like mini-armadillos. They roll up into a ball for protection.

Snails appear once in a while in a worm bin. They are quite delicate and tiny.

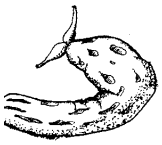
Fruit flies are not harmful but they do reproduce quickly! They are small but if you look closely, they are somewhat stout for their size (as compared to skinny fungus gnats, below).

Enchytraeids (en-kee-tray-ids), also called white worms or pot worms, can be confused with "baby worms." These tiny worms can appear in large numbers and are white.

Fungus gnats are often confused with fruit flies and can also appear around potted plants as they love soil, fungi, and tender plant roots. They are daintier looking, resembling tiny mosquitoes.

Centipedes are predators of the compost and they do eat earthworms, so you don't want too many of them, if any, in your worm bin! They have longer legs than millipedes.

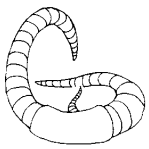
Redworms (wigglers) are found in compost piles, decaying manure or leaves, and worm bins. They are more slender than the garden-variety worms, have a reddish hue, and sometimes yellow stripes along their segments.



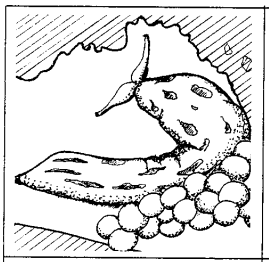
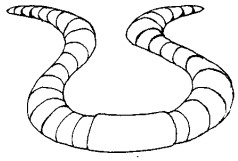
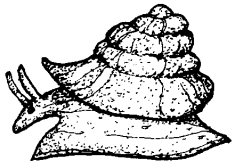
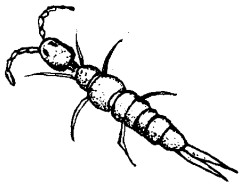
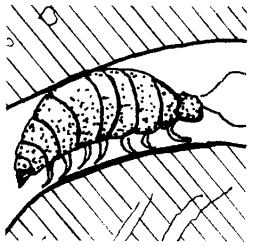
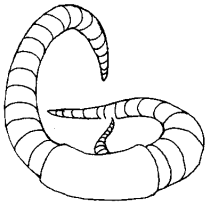
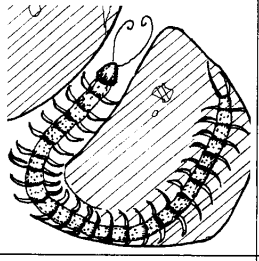
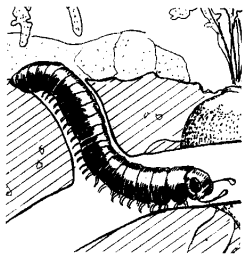
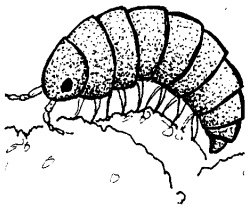
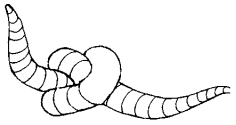
Slugs are basically snails without their shells—but they start out shell-less. If you look closely at a side, you might see their breathing hole.

Worm Cocoons (egg cases) are smaller than an apple seed, lemon-shaped, and vary in color from yellowish tan to dark brown. These cases hold two to ten worms!

Worm "Babies" are not to be confused with enchytraeids (pot or white worms), as they are small and whitish. They do have color, though, as you can see their insides (a red line) running from head to tail.



Worm Bin Bingo Card

	Draw What You Found		
	Draw What You Found		Draw What You Found
Draw What You Found			Draw What You Found
		Draw What You Found	

How to Play: Teams work together finding compost organisms. (You can use your Worm Bin Field Guides to help identify compost creatures.) When you find a compost creature, identify it by name and record an observation about it—what it was doing, how it looked, where it was, etc. For each organism you identify and observe you must get an okay from the teacher. If the teacher is satisfied with your description, and their observation, you can "X" out that organism's square on the bingo game or draw it in a blank square and "X" it out, then start looking for another. A team gets "bingo" when four blocks, vertically, horizontally, or diagonally are "X"ed out. All searching must stop when the teacher gives the signal.

From *Healthy Foods from Healthy Soils* by Elizabeth Patten and Kathy Lyons, illustrated by Helen Stevens, Tilbury House, Publishers.