

JOURNAL FOREST PRODUCTS



Wood Magic at a Distance





This Wood Sandwich event is in progress in a distance education classroom on the Virginia Tech campus. The classroom is equipped with two-way video conferencing and the activities in the remote classroom can be seen on the video monitor to the right.

Studies of environmental education show that students do not lack concern for the environment, they lack knowledge (GCM1 1997). Unfortunately, elementary school science teachers are increasingly encountering difficulties that prohibit them from allowing their students to engage in substantial amounts of the kinds of scientific experiences that would contribute to their environmental knowledge. There is a lack of time within the curriculum and a lack of necessary resources. Research has also shown that teachers are the key to successful environmental education because whether a student really learns about the environment is more dependent

on the teacher than the materials the teacher uses (NAAEE 2000). Regrettably, many elementary school teachers lack sufficient science background and therefore they are often uncomfortable teaching environmental science to children (Fort 1993). Elementary school teachers have reported that they are comfortable teaching reading, but two-thirds feel unprepared to teach science. As a result, knowledge of environmental science is often lacking in young children.

Recognizing this problem, Mississippi State University offered the first Wood Magic Science Fair™ in 1993 (Garrard et al. 1999a, 1999b). Since

WOOD MAGIC AT A DISTANCE

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then, Virginia Tech and a few other universities and organizations have developed youth education programs that reflect the unique needs and interests of their communities. Elementary school students receive only a general foundation in the area of wood science, forestry, and natural resource utilization. As a result, confusion and widespread misperceptions are created regarding the use and sustainability of America's forest resources. The Wood Magic programs attempt to address this situation. Very popular with elementary schools, the programs present active, hands-on, and engaging science-based education to third-, fourth-, and fifth-grade students and teachers, allowing them the opportunity to obtain both theoretical and practical knowledge in these areas of study.

Success of the various Wood Magic programs has been so great that literally hundreds of school classes are denied participation because of limited on-campus facilities. Developing a Wood Magic Distance Education Program (WMDEP) guarantees more widespread access to wood science learning experiences. Taking an already established and successful wood science instructional program and turning it into a distance education program greatly increases the number of students exposed to this valuable information.

Elements of a Distance Education Program for Elementary Students

Distance education takes place when an instructor and students are separated by physical distance. Technology (often in combination with face-to-face communication) is used to bridge the instructional gap. Distance education can be found in many forms, such as print-based curricula (traditional correspondence courses), video-based instruction, and computer-based courses, now particularly popular via the Internet.

Video-based instruction, specifically, interactive video conferencing (IVC), has proven to be an effective distance education technology. When using these two-way video/audio systems, real-time interaction between the instructor and the students can be provided. The remote instructor and the students can easily interact because they are all "present" in real time and can hear and see each other. Students may ask challenging questions and the expert remote instructor can answer those questions, rather than the home classroom teacher. IVC using broadband communications provides the best image and sound quality for a distance education lesson, but this option is probably only available in



This student is attempting to blow soap bubbles through a wood dowel. During this lesson, the students learn about the permeability of different types of wood and their cell structure.

affluent school districts or at nearby colleges or universities. However, many K-12 school systems are beginning to implement video conferencing using desktop computers and a standard Internet connection. Both conferencing technologies can achieve the same outcomes, but the desktop systems are less expensive and more readily available.

Video conferencing instruction has the benefit of reaching many students in the same real-time setting, but at different geographic locations (Olcott 1999). It also gives the students a more realistic instruction in comparison to a textbook, which is essential when young children are the learners (Simonson et al. 2000). Learning needs to be an engaging experience for children. If it is not, they tend to lose interest and the motivation to learn.

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Visuals provide a concrete reference point for students, and can help them by simplifying the information. A visual that breaks down a complex idea into its components can show relationships that might be otherwise confusing to students (Simonson et al. 2000).

Learning processes connected to environmental science can begin quite early according to cognitive development theory. Children are able to understand the content and the efforts that are being made to protect the environment and the science that supports these efforts. By the time children reach age 7, they are intellectually able to take the information they are presented and understand concepts that will support the environment. By age 11, they want to use scientific reasoning to understand environmental sciences and phenomena. One noted cognitive psychologist, Jean Piaget, believed that intelligence reaches its peak between the ages of 11 to 15 (Tanner and Inhelder 1960). He has even suggested that human intelligence may be superior at that point to that of adulthood. Therefore, it is crucial to provide effective science education to young students.

Distance education could provide a mechanism for students and teachers to become more involved in environmental science by providing concrete, multisensory learning experiences based in scientific fact. Consequently, we have developed an instructional design model to partially meet the needs of instructors who are interested in utilizing distance education and have applied the model to the creation of a WMDEP. An instructional design model should contain enough detail to establish guidelines for managing the people, places, and things that will interact together, and to estimate the resources required to complete the program planning (Gustafson and Branch 1997).

A WMDEP is an interactive program with the purpose of teaching children about environmental science, particularly wood science, through hands-on,

multisensory activities. The following are the types of things children could learn in the program: how paper is made and recycled, the strength and stiffness of wood, how plywood and other wood composites are made, some of the unusual things in which wood and forest products are found, how to plant trees, the cell structure of wood and how the cell structure influences properties and processing, and how many trees are planted for each tree harvested. Currently, we have only fully implemented one of these activities in a distance education environment, the Wood Sandwich lesson (making plywood), and we will use this as our example. The photographs in this article show activities happening during a Wood Magic Show on the campus of Virginia Tech. All of these projects could potentially fit the instructional design model described here, and we hope to develop many of them as distance education lessons in the near future.



The strength of sticks of wood in bending is being tested here by loading the bucket that has been suspended from the stick with rocks until the stick breaks. During this lesson, students also discover the influence of growth rings on the strength of wood.

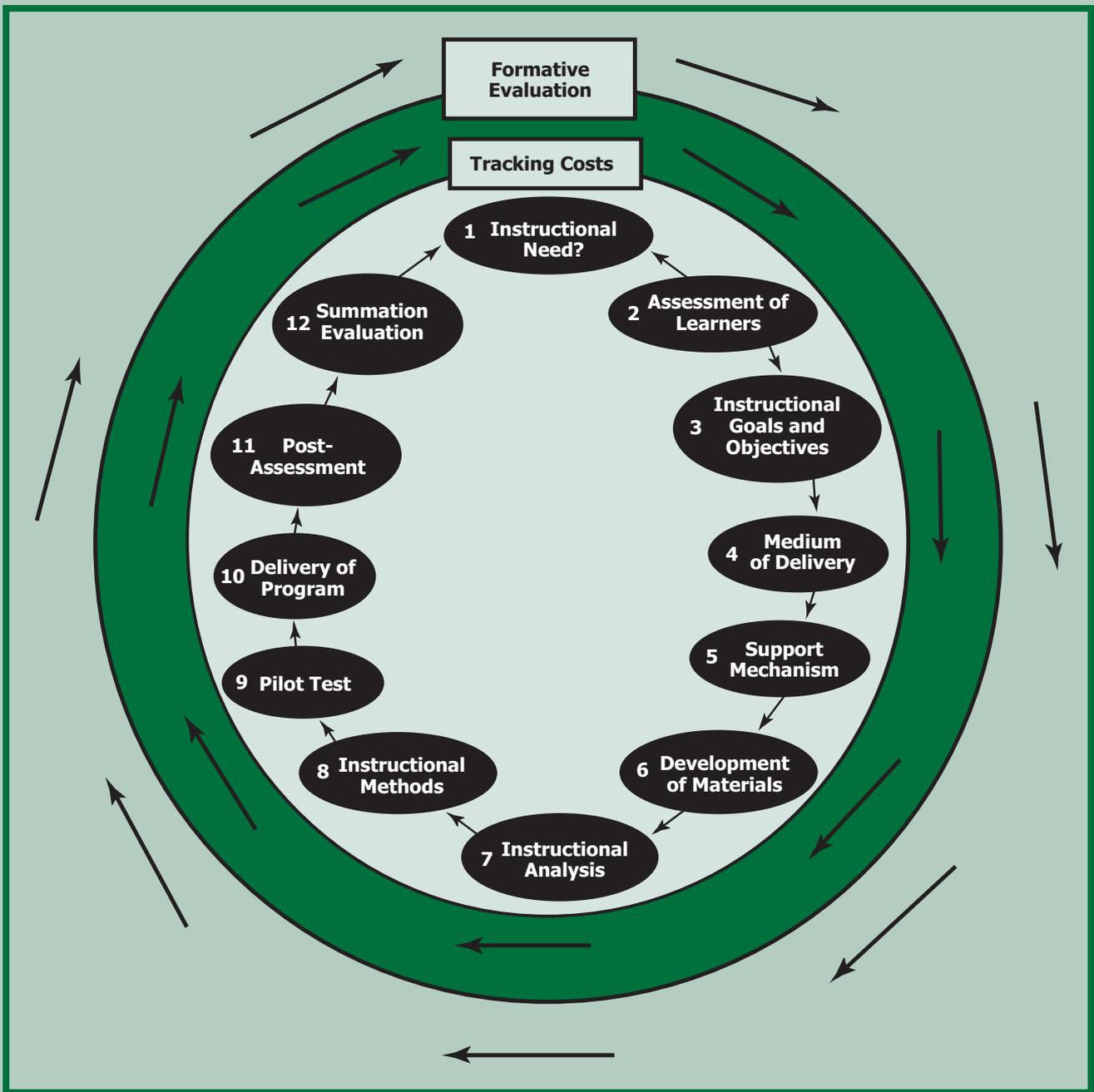


Figure 1. — Instructional design model.

Steps in the Development of a Distance Education Program

Figure 1 illustrates our instructional design model. Two components involved in this design model, formative evaluation and tracking costs, occur continuously. Formative evaluation is an ongoing process that is apparent in all stages of development. The intent is to evaluate and improve

instruction within the course or program. Tracking the costs (keeping a running tab of all expenses) is essential when designing any program. Once the course or program has been fully developed, the designer can use this detailed list of all the expenses incurred during development to gauge how much it will cost to fund the program in the future.

The *first step* in our instructional design model (refer to Fig. 1 for steps) is to conduct an analysis to determine what the instructional need is for this

program and what the intended outcome may be. The need for elementary school students to have a better understanding of environmental science issues has been previously described. The target audience is fourth- and fifth-grade students (ages 9 to 11), as well as their teachers. The program would last approximately an hour and a half and would be a supplement to information that students study in their regular science class, particularly in the environmental science area.

The **second step** is to perform an assessment of the learners to gauge their level of understanding in the areas to be taught. A pre-assessment worksheet should be distributed by the elementary school teachers prior to participating in the WMDEP. The worksheet would ask students questions in relation to wood science, in particular to the activities they will perform in a WMDEP. The same worksheet would be distributed to the students after the program as the post-assessment phase.

The **third step** is to clearly define the instructional goals and objectives prior to the development of program content. For example, the overall goal for the Wood Sandwich lesson is for learners to implement the processes necessary to make plywood. The following are the instructional objectives for Wood Sandwich:

- Objective 1 (cognitive): Given pieces of wood veneer, learners will be able to define and identify the grain in each.
- Objective 2 (cognitive): Learners will formulate a relationship between grain direction and strength and stiffness.
- Objective 3 (psychomotor): Given several pieces of veneer, learners will arrange the pieces to produce a sheet of plywood that will have maximum strength and stiffness.

The **fourth step** is to determine what medium will be used for program delivery. IVC would be the preferable delivery mode for the WMDEP, as it provides real-time interaction between the instructor and children, in addition to supporting high-quality visual displays of instructional materials and activities, such as demonstrations or experiments.

The **fifth step** is to develop support mechanisms for the program. For the WMDEP, such mechanisms could include a website that offers instructions on what lab materials will be needed and suggestions on where to obtain them, library resources, a registration form that asks for the teacher's e-mail



Students learn that reforestation means new trees are planted after harvesting is complete.

address, and a feedback form to be completed after the program. This site could also include links to other interactive sites that are student-centered and to environmental science links for the benefit of the teacher and students. Each classroom teacher should be able to sign up his or her classes by using an online registration form.

The **sixth step** is to develop the materials for the program. Wood Magic lessons would typically include a variety of materials. Printed worksheets can be used to stimulate discussion and for assessment. PowerPoint presentations could be integrated into the lessons to present the steps within each of the activities. In the Wood Sandwich example, concrete materials such as pieces of veneer, glue paper, and irons are necessary for students to simulate the creation of plywood. Such activities allow the students to create real samples of different items that utilize wood, and this is an illustration of the hands-on learning concept.

The **seventh step**, instructional analysis, and **eighth step**, instructional methods selection, can be completed simultaneously. In the instructional analysis, the instructor must decide what skills the

students will be utilizing during the learning process, and what tasks the students will perform. Will they use problem solving or procedural knowledge? Will the subject require psychomotor skills? Once those factors are determined, the instructional methods can be chosen. The Wood Sandwich lesson targets the learning of both declarative and procedural knowledge, and so involves the use of several instructional strategies. Students can learn primary factual information about plywood from a presentation by the distance instructor. Learners can also watch the instructor demonstrate the process of creating the "wood sandwich" via video, and then be guided through the same hands-on process by the classroom teacher.

The **ninth step** is to conduct pilot tests of the new program with students and colleagues to generate feedback. The pilot tests allow the instructor to improve the design or delivery and make other changes. The first pilot test should be conducted with a group of fourth- and fifth-grade students and the second test with a group of teachers. The pilot tests should aid in determining what was and was not understood so that subsequent programs can be sufficiently informative and the learning objectives mastered.

The **tenth step** is the actual instructional delivery, i.e., the instructor implements the course design. Prior to delivery, technical support must be arranged and made available for the instructor as well as for the remote sites that will be participating in the program. If centralized sites are involved in the instruction, such as with IVC, volunteers at the remote sites must have training with the equipment



Students examine live termites and discuss details of the life cycle of termites. They also learn why termites can use wood for food while other insects cannot.

in the room and the students should have already received materials pertaining to the class.

The **eleventh step** is to conduct a post-assessment of the students. As mentioned, a pre-assessment was conducted to determine knowledge level before delivery (second step). A post-assessment should also be conducted to determine the level of knowledge after delivery of the program. This assessment of learning from the WMDEP should be conducted immediately after the program's implementation. The same worksheet that was used in the pre-assessment phase would be distributed to the students the day after they experienced the WMDEP, but it would include an additional section for comments.

The **twelfth step** is to conduct a summative evaluation of the course or program after each delivery. The teachers and students who participated in the programs should also participate in the evaluation. The teachers should fill out a simple evaluation form available online in the week following the program. The teachers would review student post-assessment worksheets, and make comments accordingly on their online survey.

Sample Unit of Instruction – Wood Sandwich

Participants in this activity make a piece of plywood, or what the WMDEP calls a "Wood Sandwich." Within Piaget's concrete operational thought stage (Brainerd 1978), this activity involves the process called seriation that refers to the ability to put items in a series or sequence. The children are utilizing this learning process when asked to place the wood veneer in a particular order.

The activity begins with the facilitator (probably their classroom teacher) passing out pieces of veneer and asking the students to bend them with and against the grain. This allows them to see and "feel" the stiffness of the wood in the different directions. It is explained to them how the plywood is made stiffer when the grain is alternated. The learners then have the opportunity to try using their own materials. A comparison is then made between making a toasted cheese sandwich and making a piece of plywood. Readers who would like additional instructions and illustrations, are directed to the following websites:

<http://www.woodmagic.vt.edu/Instructions/PDF/Sandwich.pdf>;

<http://www.cfr.msstate.edu/wmsf1/usersguide.html>/Plywood;

http://woodscience.oregonstate.edu/woodmagic/lesson_plans/



These students are flexing their stack of wood veneer to determine the best configuration for the various plys.

Materials Needed (available at home improvement stores)

- Thin pieces of wood veneer about 6 inches (152.4 mm) square and 0.03 to 0.125 inch (0.75 to 3.0 mm) in thickness
- Phenol-formaldehyde film adhesive sheets cut to 6-inch squares or liquid wood glue
- VERY hot iron or lab bench press with heated platens such as Carver Laboratory Press, Model C with a hydraulic unit
- Binder clips or clamps (only necessary if using hot iron rather than lab press or the liquid wood glue rather than the glue paper sheets)
- Bread, cheese slices, and a toasted cheese sandwich (optional, but helpful for relating the wood, glue, and the completed wood sandwich to the process of making a toasted cheese sandwich)

Instructions

1. Each participant will receive three pieces of veneer and two pieces of glue sheet.
2. Demonstrate the assembly process to the learners and allow them to follow along with you.
3. Stack three veneer sheets together, making sure the grain is in the same direction.
4. Have the learners slightly bend the veneer, noticing its stiffness. Caution them not to bend it too far, causing it to snap.

5. Then ask them to change the direction of one piece of veneer, so that the grain of each is in opposition to one another (perpendicular). Have the learners again slightly bend the veneer stack, observing the stiffness now. This test should demonstrate to the learner how much stiffer the stack is when the veneers are placed in opposing directions.

6. Next, have the learners place one piece of glue sheet between each piece of veneer, so that it resembles a triple-decker sandwich. The paper glue adhesive will flow and become tacky upon application of heat in the press or with the iron. If you are using liquid glue instead of the paper adhesive, have the learners lightly spread the liquid wood glue on the surfaces of two wood veneer sheets. There is no need to use heat if you are using the liquid glue. Assemble the panel in the triple-decker, crossed-ply arrangement and then proceed to the clamping part of step 8 below.

7. If using a lab bench press, place the veneer and glue stack in the preheated press and close the press. Temperature of the platens should average about 150°C for thin pieces (0.75 mm) and can be as high as 175°C for the thicker pieces (3.0 mm). A load of 5 metric tons should be applied continuously for about 8 minutes. Remove the load and the plywood from the press and allow to cool before handling. One piece of plywood should be pressed at a time.

8. If using an iron, place a piece of aluminum foil on either side of the stack so that the wood will not stick to the iron face. Set the iron to the highest heat setting, no steam. Once the iron is hot, apply pressure in a sliding motion for 5 minutes on each side of the 3-ply stack. Carefully test the bond integrity by attempting to pull apart the wood veneer. If the bond seems sufficient, proceed with the clamping, if it does not, apply heat and pressure until the bond is sufficiently formed. Once a sufficient bond is formed, clamp each side of the plywood with binder clips or clamps. Clamp with at least eight clamps and leave the clamps in place for 10 to 30 minutes. A weight may be placed covering the center of the stack surface if available.

9. Each student now has a mini-sample of plywood.

After the activity is completed, the distance instructor will review the information with the learners. He or she should verbally go over the goal and objectives with the participants and ask simple questions to "test" their understanding. This is an easy

method of assessing student learning to see if they retained any information by going through the process of this activity.

Contributions of a WMDEP

The "Big Picture" for this program is for the participants to be exposed to science material that would complement their current studies in a way that provides hands-on learning experiences. Wood is one of the most accessible, versatile, and renewable of our natural resources. Because of wood's efficiency in cost and strength, it is one of the most utilized natural resources. The WMDEP is designed to teach the importance of wood and the variety of ways in which it is used in everyday life. Participants in a WMDEP also formulate relationships between wood, science, and technology. They experience real-world applications for theoretical knowledge attained from science instruction and learn to use, reuse, and recycle wood products in a variety of ways.

The distance education environment is especially powerful and currently being implemented nationally and internationally. The benefits of incorporating IVC technologies began with use in the higher institutions of education and IVC programs are now exponentially growing in the K-12 arena. By implementing the WMDEP into current curricula, not only are students and teachers receiving factual information and participating in hands-on scientific activities, they are also gaining valuable experience with newer information technologies.

A survey of randomly selected third-, fourth-, and fifth-grade elementary school science teachers in Virginia indicated that barriers to implementing distance education in current school curricula included the cost of materials, the time required for teachers to prepare the lesson materials and schedule the distance lesson, and possible travel expenses (Pugh 2002). Some of these barriers could be overcome by developing a WMDEP for the teachers themselves. This would allow teachers to bring the skills, materials, and activities learned at the WMDEP back into their own classrooms to use at their convenience. This option benefits the students while eliminating some of the barriers perceived by the teachers. We have not developed a teacher version of WMDEP, but the general design methodology described in this article could also be used for that purpose.

Although the specific goal of a WMDEP is to improve student learning in areas of environmental sciences such as wood science, overall teacher knowledge in these areas would be improved as well.



By sanding blocks of wood, students learn that it is very easy to eliminate surface defects and reuse or recycle wood into new products.

This will aid in overcoming the fears of teaching science that have been reported as being so prevalent today. It would fill gaps in knowledge and clarify areas that are controversial. A WMDEP would also provide a resource for students and teachers to become more involved in environmental science activities. Informal evaluations of students' attitudes toward science and wood utilization conducted after Wood Magic programs offered by Virginia Tech indicate an increase in their enjoyment of science. Widespread use of a WMDEP could help eliminate the two problems previously identified: the common misperceptions regarding the use and sustainability of American forests today and the lack of hands-on science programs for children ages 9 to 11.

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