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EFFECTIVE USE OF MULTIMEDIA IN THE CLASSROOM:
ENHANCING THIRD GRADE SCIENCE CURRICULUM

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Education: Instructional Technology

by
Patricia Bower
June 1997


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June 1997

Approved by:


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5/5/97
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ABSTRACT

This project addresses the need of implementing the California State Framework for Science in elementary schools by using technology as an instructional tool.

In order to become productive citizens in the next century, students today must learn how to think rationally, creatively, become problem solvers, obtain the skills necessary to retrieve information both electronically and textually, and communicate effectively. The integration into the curriculum of different technologies such as CD-ROM, internet, email, multimedia, and other software applications as tools for information literacy is addressed in this project. The project further addresses the need for a science software that is developmentally appropriate, considers the needs of learners, provides for a multimedia learning experience, and allows the students the opportunity to construct meaning from their involvement with the content material.

In addressing the above goals, this project includes the design of a multimedia stack to be used as supplemental material in conjunction with the earth science curriculum in third grade. The stacks are both teacher and student generated.

ACKNOWLEDGEMENTS

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CHAPTER ONE

Introduction

In recent years the California State Science Framework has undergone significant changes in the area of teaching science at the elementary school level. Students are now required to be actively engaged in learning about the natural and technological world that surrounds them in their everyday lives. Instructional activities should be designed so that students can take charge of learning the major concepts of science rather than the teacher providing direct instruction (Neden, 1994). Active learning is most closely tied to hands-on laboratory experiences, but there are many other forms of active learning including: active reading; listening; discourse; and using new learning technologies such as the computer, internet resources, and CD-ROM software (California State Board of Education, 1990).

The new science state framework encourages the integration of technology in the teaching of the earth science concepts of astronomy. Students are usually taught about the solar system and other related topics by reading the information out of a textbook or listening to a teacher lecture about such concepts. Occasionally, an age inappropriate video of the topic would be shown to provide visual images of the concepts being taught. Assessment or evaluation of what learning took place usually takes the form of a written exam at the end of the learned section (Selby, 1993).

An innovative approach to teaching science processes is one that provides students with opportunities to rely on their own natural curiosities and to guide them through a process of discovering answers to questions they have generated, not questions provided by the teacher (Vincent, 1993). By doing this the students learn science concepts using the guided discovery approach. The traditional use for discovery learning of a textbook is supplemented with additional technologies such as the internet, CD-ROM, software, reference materials, and a teacher created multimedia presentation. Multimedia materials often enable students to obtain additional information about the subject matter in a non-linear fashion. Once the students have gathered this information, they can begin the process of arriving at an answer to their original question. The students create new knowledge based on previous learned concepts and devise a way to present these new ideas. The formal assessment takes place at the end of the process in the form of a student-created multimedia report which provides answers to the student-generated questions. The students in turn become the teachers and the teacher becomes a learner (Beasley, 1992).

The basic content of all science concepts consists of hypotheses and theories that can be observed and have meaning. The science process of observing, communicating, comparing, ordering, categorizing, relating, inferring, and applying are all skills that students need to possess in order to understand these basic science concepts. These

processes also are considered to be life skills that will help the students begin to understand a variety of concepts in other curricular areas (Davis, 1994). This underlying focus of this project takes the position that through the use of technology, these processes can be actively achieved and used to provide the student with legitimate learning.

The skills of information literacy are also introduced to the student. An information literate person has the ability to access, evaluate, and use information from a variety of sources. An information literate person can recognize the need for information, formulate questions based on his or her information needs, identify potential sources of information, develop successful search strategies, and access print and technology-based sources of information. The information literate person also needs to be a competent reader. Students will use these information processing and literacy skills to research and find the answer to their questions. The research base is broadened and goes beyond the school required textbooks. A variety of technology-based resources will be used to complete this research.

Multimedia technology is reported to be useful in reinforcing what was learned from the text as well as provide additional information that might inspire the student to learn more about a particular topic. Color, movement, sound, and developmentally appropriate text would help to motivate the student to continue to learn about the topic. The use of visual aids, graphics, and auditory reinforcement can help those students that find it difficult to learn by

reading out of a textbook (Barba, Pang, Santa Cruz, 1993). The software would provide a different modality for learning. Additional information could be acquired from internet resources, CD-ROM, or other software applications.

Another use for the software would be to help students who missed a lesson due to an absence or release time from the classroom to catch up with the remaining students in the class. This would eliminate the need for the teacher to reteach the lesson to one or two students. Students who find a particular concept difficult to grasp can use the stack to relearn the concepts or experience the information in a different manner. It is important that a teacher offer as many different methods of presenting learning materials to his or her students as possible. Not everyone learns in the same manner.

The use of computer technology in delivering earth science instruction supports the learning theory of constructivism (Toomey, 1995). The heart of a constructivist science curriculum is involvement in meaningful hands-on activities. According to Toomey, knowledge is not something that can be written on an "empty slate" in a student's brain. Each student develops explanations to different scientific phenomena based on his or her prior experience. Through the interactions provided by these activities, students are able to reconstruct previously developed explanations or concepts (Biehler & Snowman, 1991). A software program designed with this in mind can provide that experience to the learner. Visiting a museum or reading a manual will not provide the

learner with the first-hand experience or "interaction" with the material that a computer program can provide. Since the content area in the earth sciences for third grader students revolves around the topics associated with outer space, first hand experience is practically all but an impossibility. However, through the use of technology, the students will be able to access the latest information, pictures, and research available from such agencies as National Agency on Space Advancement (NASA) and the Jet Propulsion Laboratory (JPL). This information will be used to solve problems.

Students need to be provided the opportunity to explore areas that are puzzling or unclear in their understanding of earth science and astronomy. The students will take complete ownership of their learning as they discover the answers to those concepts that do not make sense to them.

Statement of the Problem

The study of the relationships that the Earth, moon, and sun have on each other is a large portion of the California science curriculum in the third grade (California State Board of Education, 1990). Teaching these relationships requires detailed coverage of the different phases of the moon, rotation versus revolution, the reason for the different season, and how the sun and moon effect our Earth. Many existing software programs deal with the entire solar system, including all planets and their moons. There does not seem to be any type of software or other

instructional technology that deals specifically with teaching primary-aged students about the concept of the Earth's moon and the sun and the effect that they have on each other. There is however plenty of educational software that covers these specific topics for students age ten and above (Hauhland, 1988). An informal review of several different software applications designed around this content area indicate that there is difficulty in finding developmentally appropriate instructional software available for students in the third grade.

The Etiwanda School District, located in Southern California with a population of approximately 5,400 students, uses a science program called A System In The Sky (Macmillan/Mcgraw-Hill, 1993) that provides instructional materials to support the science curriculum mandated by the state science frameworks. The teachers in this district are required to use this material in presenting the content area information. The main source of information is delivered by the use of a student textbook. A few colored overheads are also provided to stimulate interest. However, the program does not include any computer based multimedia material that would enhance learning, including information literacy skills, as well as increase students' interest.

Project Overview

This project involves the development of a unit in science that integrates the use of technology in the problem-

solving approach and the development of information literacy skills. Included as part of this plan is a teacher-created hypermedia stack to serve as an additional resource. The following science concepts will be addressed: rotation, revolution, day and night, distances, solar and lunar eclipses, gravity, moons, stars, and the planets. There will be a set of activities designed to help the students learn the concepts with an emphasis on process skills. The project also provides a set of references which include CD-ROM and a variety of web sites.

The unit plan will model the process approach to teaching science. Information literacy skills will be used to integrate technology into the process. The teacher-created stack on the other hand will address the developmentally appropriate needs of the third grade students.

This project is not a content unit presented in and of itself, but rather a process unit based on the guided discovery method of teaching science. The students will be introduced to specific topics revolving around earth science at a third grade level. This exposure, in turn, will provide the environment for the students to generate questions amongst themselves about the subject matter. The teacher will act as a facilitator, guiding the students' discussions and questions in the appropriate curriculum direction. This curiosity to find answers to the problems using the scientific process, data gathering techniques using technology, critical thinking skills, and presentation

development using multimedia will be the core focus of this project.

The prerequisite skills that the students must possess to successfully participate in this project include: the ability to read at a third grade level, the ability to write at a third grade level, and they must possess basic computer literacy skills such as knowing the parts of the computer, remedial keyboarding skills, knowledge of saving data to a disk, and how to print on hard copy. All of these computer skills have been taught to the students participating in this project during second grade and reviewed at the beginning of third grade.

The process of this project involves many steps. First, the teacher will present materials related to the content area to the students. A large group discussion about the concepts will be monitored and guided by the teacher. The teacher at this point takes on the role of facilitator not instructor. The students will in turn write down several questions that they have about the subject matter, or define certain areas that they would like to learn more about or find confusing to understand. These student generated questions will then be collected by the teacher, read, and grouped based on similar question types. The students with like questions will then be placed in collaborative groups where they begin to gather data collectively using several techniques.

The main skill that will be used by the students is that of information literacy. Information literacy is a term

that describes the skills needed to complete the process of information problem-solving (American Association of School Libraries, 1994). In order to become productive citizens in the next century, today's students must learn how to think rationally, creatively, become problem solvers, obtain the skills necessary to retrieve information both electronically and textually, and communicate effectively.

Technology plays a major part in this process of data gathering. The students will be exposed to several different technologies to find answers to the questions that they pose. The oldest and most basic form of technology to be used will be the textbook and other printed materials. Books still provide an abundance of information that cannot be found on the internet or other electronic means. The students will also use internet resources using Netscape Navigator to research areas of interest. Basic internet navigation techniques have been taught to this entire group of students. A teacher-created home page has over twenty-five appropriate links to outer space sites where the children can find additional information. Several third grade students have the internet at their own homes and have become efficient gathers of information simply through personal use and experience. These experts will also become peer tutors during the process of data gathering and help those students who are having difficulty navigating the internet. The school also has a CD-ROM program called Space Adventure (Knowledge Adventure, 1994) which is designed for intermediate grade level students (grades four through six) that can be used to

supplement the research. Finally, there is a teacher-created multimedia presentation or Computer Aided Instruction (CAI) which provides the students with age appropriate information covering the specific areas described in the content area. The students will use the skill of note-taking during this data collection process to gather their thoughts and begin formulating answers to their original questions.

The next step of the process is for the students to develop their critical thinking skills by comparing and contrasting all the information that they have gathered and begin to devise answers to be presented to the class in a multimedia format. The electronic presentation must be organized, developed, and communicated in an effective manner. Here the student needs to build upon existing computer skills and learn how to create hypermedia.

CHAPTER TWO

Literature Review Introduction

If the astronomy unit and related author-created software is to achieve the objectives stated in the previous chapter, it must be structured to current standards in elementary science education; be rooted in constructivist learning theory; and introduce technology into the curriculum. As a result of a review of current educational literature, this chapter will show the link between these objectives and the design of the curriculum unit and software. The topics to be reviewed include science instruction, cognitivism, the integration of technology into the curriculum, information literacy, and the effective use of multimedia software.

The Nature of Science

Science is a field that is constantly changing with new findings in basic knowledge, medicine, and technology. The essence of science is the process of critical thinking and asking thoughtful questions. These are skills which today's students need to master. It is important for children to comprehend how the natural world works so they can be well prepared for decisions they must make as adults (Anderson, 1994). Decisions in the next century will be increasingly dependent on a clear understanding of science.

Science includes thorough observations which are driven

by curiosity (Beichner & Dobey, 1994). In addition to this, the sharing of ideas and findings with others is an equally important facet of the science process. In the scientific world, the results of a research study are only published and become a part of the body of knowledge after it has been reviewed and discussed with other scientists. This communication aspect is what really distinguishes a scientist from just a casual observer.

Working together in collaborative groups is also a large part of the scientific process. Students should become comfortable with working together and sharing ideas. In the past, this might have been construed as cheating. Certainly, there are times when a student must work by himself, but one of the prerequisite skills of adult life is to work effectively with others. It is important that educators prepare students for adulthood; cooperative grouping is one way that this can be achieved.

According to Backes (1994), in order for science to be effective, it should also be enjoyable. Students should be actively engaged in the learning process which can be accomplished by placing them in a position of responsibility for their own learning. Experimental problem-solving encounters which have meaning to the student should be provided as much as possible in all science content areas. This can be accomplished if the teacher maintains a flexible teaching style and follows some of these guidelines in developing science concepts (California Science Framework, 1990): (1) ask the students questions about a topic to

determine their level of understanding before instruction begins; (2) take a non-judgemental stance on student's concepts of science; (3) provide a variety of instructional strategies and techniques to help the students understand the concepts; (4) all students should be included in discussions and cooperative learning groups should be formed at all possible times.

The revised California Science Framework of 1990 spells out ten specific expectations to achieve scientific literacy for all students living in the state of California. These expectations are as follows:

1. The major themes underlying science, such as energy, evolution, patterns of change, scale and structure, stability, and systems and intersections, are developed and deepened through a thematic approach.
2. The three basic fields of study-physical, earth, and life sciences-are addressed, ideally each year, and the connections among them are developed.
3. The character of science is shown to be open to inquiry and controversy and free of dogmatism; the curriculum promotes students understanding of how we come to know what we know and how we test and revise our thinking.
4. Science is presented in connection with its applications in technology and its implications for society.
5. Science is presented in connection with students' own experiences and interests, frequently using hands-on experiences that are integral to the instructional sequence.
6. Students are given the opportunities to construct the important ideas of science, which are then developed in depth, through inquiry and investigation.
7. Instructional strategies and materials allow several levels and pathways of access so that all students can experience both challenge and success.

8. Printed materials are written in an interesting and engaging narrative style; in particular, vocabulary is used to facilitate understanding rather than as an end in itself.
9. Textbooks are not the sole source of the curriculum; everyday materials and laboratory experiments, videotapes and software, and other printed materials such as reference books provide a substantial part of student experience.
10. Assessment programs are aligned with the instructional program in both content and format; student performance and investigation play the same central role in assessment that they do in instruction. (California State Framework, 1990 p.9)

Scientists are problem posers and problem solvers. They ask questions about the world they live in which makes them curious. But, they also act on that curiosity by trying to find the answers to their questions. Sometimes they try to use the scientific method of hypothesis generation, experimentation, and prediction. Sometimes they use a haphazard trial and error method. Most of the times they act between these two extremes. Scientists use their intuition and their own background knowledge to guide them towards the answer. Sometimes this search is straight forward, many times it is not but they continue to search for ways to solve problems presented by nature (Shapiro, 1994).

Sometimes theories become so complex and unwieldy that the best solution is for the scientist to tear it apart and start all over again. Scientists are like young children in that they both possess tenacity and curiosity, both prime characteristics to become an outstanding scientist. Then why is it that all children do not become scientists? That natural curiosity has been stifled by traditional teaching

methods which require the dissemination of information and the recall of facts rather than student-centered meaningful experiences where new knowledge is obtained by the student (Fosnot, 1996).

This problem solving approach to science is not completely without guidelines. First, there are certain facts that provide a body of knowledge to the scientific community. These facts were ascertained through the process of experimentation and observation. Second, there are certain technical skills that are required to collect scientific data. These science process often include observation and measurement skills. Finally, scientists are curious but also open minded in their views. They must display enough self-control to refrain from making judgments before sufficient evidence is collected. A skeptical personality is a desirable characteristic of a good scientist (Threadgust, 1996).

The elementary science program is full of areas where the teacher can capitalize on the joy of learning and natural curiosities of young children. New instructional technologies can help supplement the learning of concepts to help make science enjoyable, interesting, and most importantly meaningful. Technology can provide connections to current information, experiences, pictures, and the opportunity to fail in a safe environment. With the increased usage of technology in the classroom, the teacher assumes a new role; that of facilitator of student learning instead of disseminator of information (Sheingold, 1991).

The goals of a science program should be for the

students to obtain scientific literacy and to understand the world in which they live. Traditional assessment such as vocabulary test and knowledge recall will not measure whether or not that goal has been achieved. The development and design of the assessment tool will require as much detailed consideration as the development of the instructional program itself.

The Philosophy of Science Teaching

There are several arguments about the philosophy of how science should be taught to elementary-aged children (Beichner & Dobey, 1994). For starters, there is the all-or-nothing argument that implies that a teacher's responsibility is to teach the important scientific facts and concepts to the students. Allowing the students to explore and discover concepts on their own is an inefficient process which might result in misconceptions made on the students' part. It is true that there is an important body of information that students must learn in order to survive as adults in today's complex world. It might be more efficient for a teacher to simply hand out a list of facts and have the students memorize the information and be tested. But will the students understand the material, retain the information at a later date, or be able to apply that knowledge in other situations? Sometimes in science teaching, less is more. It is more important to cover fewer topics in greater depth than a brief overview of many concepts. It is crucial that the students have a full understanding of how the different science

concepts fit together; how the systems relate to each other.

The content-driven versus open-ended curriculum argument implies that the teacher should stick to an outline of topics to be covered rather than giving the students free reign as to which direction to follow. If the students are allowed to go off on their own, they may miss some of the key facts and principles of the content area.

This philosophy is closely tied to the all-or-nothing approach. Using this method is also an effective way of teaching, however it is not an effective way of learning or retaining information. Researchers have determined that children learn best when they are given the opportunity to construct their own meaning for concepts. Students will learn and remember more if they are taught in this manner. Children tend to be more highly motivated to learn about science if instruction is designed around the open-ended curriculum approach. Individual learning style can be better matched if the students themselves have a say in the approach that is to be taken. This works especially well if the students have been taught metacognitive strategies such as concept mapping or advanced organizing skills. It is critical that the teacher remain flexible and address the questions that are interesting to the children, not just to the teacher. The teacher's job is to design a program which carefully balances the ideas of the content and open-ended approaches. Allowing the students to simply follow their whims does them a disservice. The central concepts of any given area of study needs to be addressed. But, a curriculum which is designed

to ignore or discourage student interests will certainly decrease the chances of the students ever being interested in learning more about the subject matter.

The textbook/worksheet orientation versus free for all labs argument implies that the schools are poorly equipped to handle hands-on experiments. These types of activities require extended amounts of time and effort, many teachers feel that the children are simply playing instead of working. Instructors are concerned that the students may miss learning the concepts that are important from the teacher's viewpoint.

Teacher who are uncomfortable with their own level of scientific understanding and fear that they will not be able to explain events as they occur usually adhere to the textbook/worksheet philosophy. These teachers feel that following the textbook is a much safer road to take. Teachers need to be more open-minded and flexible in giving up the full responsibility of being a walking book of knowledge. Teachers can not possibly know every answer to every question that arises, especially in the science curriculum. More responsibility should be placed on the shoulders of the students. Let them design the experiments using everyday materials that can be found at home or other common places. Let them find the answers to their questions on their own. With the students' increased involvement, the idea that science experimentation or research is expensive and can only be achieved in a laboratory will be dispelled.

The type of thinking skills that are developed by designing, implementing, and analyzing experiments are key to

science and other areas. All of these skills that are encountered in experimentation and research are related to formal thinking levels. How can we expect students to perform higher levels of thinking without giving them the practice in the first place? These skills are not germane to science alone, but can be transferred to other areas.

Finally, the content versus process versus attitudes argument sums up the battle of science philosophies in the best fashion. The content argument has already been discussed. The process philosophy teachers believe that factual teaching is misspent on primary-aged children. These instructors believe that it is more important for the children to learn the process or skills of science rather than content areas. Students' time is better spent on learning how to measure distance and temperature, single out and control variables in experiments, and learn how science is accomplished. The last argument supplied by some teachers implies that what really counts in teaching science is not the content or process of science that matters, but rather the development of positive attitudes that children have towards science. Getting students to like science is the main goal.

The best possible science philosophy is a combination of all these arguments (Hutchinson, 1991). A program should be designed to stress important facts and skills, with hands-on experiments applied at appropriate times, and freedom for the students to explore on their own with the teacher's guidance. Student should naturally have a positive feeling towards

science if these approaches are implemented.

Science Instruction and Cognitivism

The guided discovery, inquiry, or problem solving methods of teaching science are built around the constructivism learning theory. Knowledge accumulates through the process of building on prior experiences and understandings. Students are able to construct new ideas by somehow combining new information into the concepts that are already in place. Many times the fit of new information is so misaligned with old information that the student is unable to apply the new knowledge to other situations. There is no meaning outside of the classroom and the student has difficulty transferring principles (Shapiro, 1994).

The Association of Supervision and Curriculum Development (ASCD) has developed a four step process for guiding learning through the constructivist approach (Beichner, Dobe, 1994). This model is essentially the problems approach method which was mentioned earlier. The first stage is to have the learner become engaged by teacher or student generated questions. The teacher can prepare the list of questions ahead of time from something a student has recently observed or experienced, or the questions could be related to current events. At this point, the teacher is able to determine what level of prior knowledge or understanding about the topic the students possess. This first stage allows the teacher to invite the students to learn, not just feed information to them.

In the second stage the students are allowed to discover what they can about the question(s) at hand. The teacher allows the students the opportunity to explore, discover, and create answers of their own to these questions. Different reference materials should be made available to the students such as textbooks, library materials, internet access, CD-ROM programs and other software items. The students should also be able to experience hands-on activities at this point if it is appropriate.

The third stage will naturally occur from the activities of the second stage. The students talk amongst themselves and others to propose explanations and solutions to the questions. Through the research efforts and hands-on experiences the students put all the pieces together and come up with a good explanation of the problem at hand.

The last step is for the students to take action on what they have learned. At this point the students have integrated the new information with their prior knowledge and have created a new knowledge base which they will continue to build upon. The learners will construct a new conceptual understanding of the subject matter, or create a conceptual change, having gone through the process of exploration, remembering prior experiences, research work from information competency skills, hands-on experiences, and guidance from the teacher. The students could also present their new knowledge to other students and become teachers themselves (Johnson, 1995).

Brooks (1990) devised the following list of approaches

to be an effective constructivist teacher:

- Encourage and accept student autonomy, initiation, and leadership
- Allow student thinking to drive lessons. Shift content and instructional strategy based on student responses.
- Ask students to elaborate on their responses.
- Allow wait-time for asking questions.
- Encourage students to interact with each other and with you.
- Ask thoughtful, open-ended questions.
- Encourage students to reflect on experiences and predict future outcomes.
- Ask students to articulate their theories about concepts before presenting your understanding of the concepts.
- Look for students' alternate conceptions and design lessons addressing any misconceptions.
- Let students teach each other whenever possible. This forces them to closely examine what they know.
- Encourage other metacognitive activities. Have students think about how they learn. Let them brainstorm to learn even more.
- If you can, have each student or group of students create a tangible product. This gives them a sense of accomplishment and provides something concrete to remember; it forms a base for building additional knowledge (Beichner & Dobey, 1994 p.29-30).

According to technologist Ferguson (1988) there is a distinction between instruction and construction. The concept of instruction entails the flow of skills from one person to another. However, construction means that the learners are actively building meaning within their own minds rather than having it placed there by someone else.

Instructional technology theory, like learning theory, grew up within the behavioral mind set (Kay, 1991). Learning theorists now have made the transition to the cognitive/affective mind set. There is still plenty of

support for systems of instruction for low-level types of learning (memorizing, automatizing). However, many are beginning to adopt the notion that the construction view is far more appropriate for higher-order types of learning (Papert, 1980).

Activities mean more when used in conjunction with an organizing concept. David Ansubel's work with advanced organizers proves this theory to be true. There are three different types of organizers that teachers use in education: (1) advanced, (2) emerging, and (3) historic. Advanced organizers are those concepts that are presented ahead of time to help students make sense out of what they are about to learn. Historic organizers are those that are introduced after the instruction has taken place. Emergent organizers occur as concepts during instructional activities. Using these organizers will help the teacher and students acquire the key concepts of content and process. This in turn will make the learning more efficient and the knowledge more transferable (Todd, 1990).

The Role of Computer Technology in Instruction

Instructional technology has been present in schools for over 300 years in one form or another. Simple drawings have been replaced by digitized images, entire libraries of printed information are now stored on CD-ROM disks that can fit in one's hand, and international sharing of information can be obtained in an instant from the internet through the

use of a modem and a computer. Technology has always been growing at a steady rate, but lately the evolution in instructional technology has been occurring at an accelerated rate (Bruder, 1991).

The Commission of Instructional Technology (1970) defined instructional technology as follows:

Instructional technology can be define two ways. In its more familiar sense, it means the media born of the communication revolution which can be used for instructional purposes alongside the teacher, textbook, and blackboard... The pieces that make up instructional technology [include]: television, films, overhead projectors, computers, and other items of "hardware" and "software"... The second less familiar definition of instructional technology goes beyond any particular medium or device. In this sense, instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction (Commission on Instructional Technology, 1970 p.21).

The beginning of instructional technology can be traced back to the time when tribal priests created organization systems for bodies of knowledge and early civilizations invented pictographs or sign writing to record and transmit information. The more advanced the culture, the more complex became the technology of instruction (Saettler, 1990).

The inevitable invention of the printing press was a major breakthrough for instruction technology. Books were previously hand printed or pressed individually by means of inked carved wood blocks on which paper was press. The

printing press enabled information to be reproduced relatively inexpensively, quickly, and in mass quantities. Johann Comenius, a Moravian teacher and theologian of the seventeenth century, found a way in which to organize the printed material so as to teach several hundred pupils at once (Saettler, 1990). Comenius can be considered the inventor of modern programmed instruction. The best example of Comenius's method of instruction was his publication in 1658 of Orbus pictus (The World in Picture). This book was written for children who were studying Latin and the sciences. It is one of the first illustrated books of its kind and considered one of the most popular illustrated children's textbooks ever written. Today's instructional methods incorporate many of Comenius' ideas.

Jean Jacques Rousseau (1712-1778) recognized that instructional technology must incorporate the developmental stages of the learner. In Emile, Rousseau pointed out that instructional methods should follow the human development stages from early childhood to maturity (Saettler, 1990).

Johann Friedrich Herbart (1777-1841) was the first person to develop the systems approach to instruction through his famous four-steps learning design. His ideas about how sensory information was transformed, organized, stored, and eventually related to new experiences were the precursors to today's psychology of perception (Saettler, 1990).

Maria Montessori's (1870-1952) contributions to instructional technology include the development of the idea that sequencing of subject matter should be modified for

individual learners. Her methods of teaching are still in use today; school work was adapted to meet each individual child's needs, freedom in the classroom, and an emphasis on sensory education (Saettler, 1990).

James Sully (1842-1923) influenced the scientific concepts of educational technology by asserting that teaching was a technological process. He concluded that instruction was both an art and a science and that a teacher must be aware of the psychological laws and principles when in an instructional situation (Saettler, 1990).

Psychological Concepts of Educational Technology

These psychological laws and principles began to have an increasing impact on educational technology in the 1960's and 1970's when the behavioral sciences concept of educational technology emerged. The two radical behaviorists, John B. Watson and B.F. Skinner asserted that thoughts, images, and consciousness did not belong in the science of psychology because these areas could not be observed or measured directly. Skinner's idea of reinforcement began to influence the development of computer-assisted instruction (CAI). The behaviorist's concept of education technology is limited to the lower cognitive process of memorization and recall. Motivation is controlled through conditioning and reinforcement. The behaviorist's curriculum is broken up into small units which the learner progresses through after observable and measurable learning has taken place. The

behaviorist's viewpoints have permeated some school's curriculum systems with behavioral objectives, behavior modification, systems analysis, accountability, and performance contracting (Shapiro, 1994).

Unlike behaviorism, the cognitive approach to educational technology emphasizes knowing rather than responding and attempts to understand the internal processes of behavior (Dewey, 1910). The cognitivists believes that the learner is is not passive, but rather active in constructing new knowledge and that the learner becomes an active participant in acquiring and using new knowledge (Fosnot, 1996).

By the 1980s, the cognitivist's approach to learning began to replace the behaviorist's theories with regards to instructional design. More emphasis on learning strategies during the instructional process, rather than behavioral responses are the outcomes of this approach (Fosnot, 1996). In the future, new paradigms in educational technology will undoubtedly emerge. Educational technology in the next century may be based on entirely different methodologies and outcomes.

Integrating Technology Into Elementary Education

Technology is so deeply entwined into our lives that it is sometimes difficult to recognize. Society has become more dependent on technology for life support needs of food, clothing, and shelter than at any other point in time.

Technology can be defined as the conscious process by which people alter their environment (Ortega & Ortega, 1995).

Technology affects our lives to such a great extent that it must become an integral part of our education systems. The students of today need to become the technologically literate citizens of tomorrow. Including technology into the everyday curriculum is no longer a supplemental area of study but rather a requirement to place education in the context of the real world. Integrating technology into the curriculum will make the learning experience that much more realistic and valuable (Collins, 1991).

The transactionalist and transformationalist approach to education are embedded in integrated technology education. The development of the process skills of creativity, critical thinking, and problem-solving are the foundations of the transactionalists orientation. By solving problems using technology, the students are actively involved with the process of gaining intellectual capacity. The emotional and social growth of the students as they become involved with the natural integration of subjects is the main focus of the transformationalist approach (Ortega & Ortega, 1995).

Integrated technology education enables the students to follow their natural curiosities, be creative, and develop problem solving skills. This type of learning will help build student self-esteem, self-confidence, and provide opportunities for success (Silverman, 1995). Students are given the freedom to arrive at solutions to problems or

questions in their own unique way using whatever tools are available. Divergent and convergent thinking skills are also developed with this type of learning approach. The students begins to acquire self-discipline through their persistence at coming up with a workable solution to their problem. People skills are learned by working cooperatively with others in the group (McCade, 1995).

One of the unique factors of technology integration in education is that it can be changed to adapt to the various stages of development and student capabilities. This allows the students the opportunity to progress at their own speed, both vertically and horizontally. This flexibility is important in accommodating those students with special needs such as the gifted, non-English proficient, or slow progressing students (Glass, 1993).

The use of technology can help develop the students' process skills, motor skills, and materials handling abilities so that they become better problem solvers in the upper grades. As Williams (1985) points out, "children have a natural interest and ability to using the problem-solving approach, ... relatively young children can carry out quite involved technological activities and that their lively, inquiring minds can tackle problem-solving activities unhampered by the preconceived ideas which make original thought so difficult for older people" (p.3).

The primary teacher must take the role of planning technology activities as well as instructing the students on the proper and safe use of the equipment. The primary teacher

acts as a resource person and a facilitator to help guide the students in the development of their process skills.

Teachers will also find themselves in the role of learner. These are all roles that a primary teacher is involved in, they just need to be expanded to incorporate technology skills.

It is important to provide a great deal of interactivity in the instruction. According to Borsook (1991) the thing that makes the computer unique in the long history of educational media is its potential for interactivity. In the best games and simulations, the computer seems to disappear and the player becomes absorbed into a "simulated environment where communication between the computer program and the player is highly responsive" (p.11). Its potential for interactivity sets the computer apart from all other instructional devices. Text, color graphics, full-motion video, animation, and sound can all be transmitted via media other than the computer. However, it is the potential for interactivity that makes the computer an educational tool like no other. The educational potential is fantastic (Middleton & Balzano 1989).

Information Literacy

The Commission on Learning Resources and Instructional Technology (CLRIT) develops and recommends guidelines for effective uses of learning resources and instructional technology to the California State University System. The

idea of information literacy arose with the strategic planning to bring all California State Universities into the twenty-first century and to ensure that students are able to function well in the Information Age. Even though these skills are listed for university students the same skills can apply to elementary-aged children. One needs to understand that the level of literacy will be at a much lower level than that required at a university setting, but nonetheless the same basic skills are applicable to all children who are entering the twenty-first century as students and or adults.

Information literacy, or as it is sometime referred to as information competency, is defined as "the ability to find, evaluate, use, and communicate information in all of its various formats. Information literacy is the fusing or the integration of library literacy, computer literacy, media literacy, technological literacy, ethics, critical thinking, and communication skills." (California State University, Pomona, 1995, online).

There are three aspects that also define the concept of information competency. First, in order for the students to be competent they must possess an awareness of issues such as privacy, intellectual property, copyright and fair use policies, and the power and influence that information can have. Second, educational facilities must ensure that students are equally as successful at evaluating, generating, and interpreting nonprint media as they are at reading, analyzing, understanding, and writing more traditional print materials. Third, not only will the student be required to

find, analyze, and synthesize information but the student must also be able to create information and communicate it in an effective manner through the use of a variety of media.

According to the CSU work group in charge of specifying the core competencies, the following list provides the necessary steps for a student to become information literate.

In order to be able to find, evaluate, use, and communicate information, students must be able to demonstrate these skills in an integrated process:

1. State a research question, problem, or issue
2. Determine the information requirements for the research question, problem, or issue
3. Locate and retrieve relevant information
4. Organize information
5. Analyze and evaluate information
6. Synthesize information
7. Communicate using a variety of information technologies
8. Use the technological tools for accessing information
9. Understand the ethical, legal, and socio-political issues surrounding information and information technology
10. Use, evaluate, and treat critically information received from the mass media
11. Appreciate that the skills gained in information competence enable lifelong learning. (California State University, Pomona, 1995, online)

Why is it so important to be informational competent at this point in time? The time period from 1950 to 2000 has been designated as the Information Age. There has never been so much information available to mankind as there is now, and that information continues to grow. It is imperative that today's students acquire the necessary skill to use that information as effectively as possible in order to survive everyday life in the twenty-first century. According to the CSU report the following facts will speak for themselves:

- The average person of today will see as much information in one day as the average person saw in an entire year in the eighteenth century.
- Offices generate nearly 2.7 billion documents per year.
- The average white collar worker reads documents 24 hours a week. The average blue collar worker reads 97 minutes a day.
- Futuristic magazine has predicted that by the year 2000 about half of all service workers will be involved in collecting, analyzing, synthesizing, structuring, storing, or retrieving information as a basis of knowledge (California State University, Pomona, 1995 online).

The information explosion keeps growing exponentially as new knowledge is created at amazing rates because of the emergence of new technologies. One of the main focuses of the Information Age is the power that the student will gain through the ability to store, retrieve, and distribute information. The library community has known about information literacy for decades, but because of the emerging technologies of the internet, on-line databases, personal computers, and the power of words and graphics it is just now that it is becoming an important issue with the general public and educators (Gauger, 1995).

According to the Bulletin of the American Association for Higher Education (AAHE), students forget about fifty percent of course content presented to them within a few months. Students take with them in their heads and notebooks only about forty-two percent of the lecture content. These were the results even when the students were told that they would be tested immediately after the lecture. When students were tested without their notes a week later, they could only recall about seventeen percent of the lecture material

(Giese, 1992).

It is only obvious to conclude that with the growing production of information and the awareness of student memory loss, students must have the ability to locate information by themselves. These will be the mandatory job skills of tomorrow. Even if students had a 100 percent memory retention on course content, information is changing at such a fast rate that the information learned today may not be applicable a few years from now.

Educators have the responsibility to see to it that their students become as proficient as possible at navigating through this proliferation of print and nonprint media. These skills will enable the adults of tomorrow to lead satisfying and productive lives in the Information Age and beyond. Even though the skills of information literacy have not been completely developed in the academic curriculum, teachers need to introduce the process as soon as possible (Giese, 1992).

The assessment of information literacy should be through a student created demonstration of the skills. Possible ways of applying these competencies could be through student written web pages displaying a portfolio of their work, or the creation of a hypermedia project or resume to demonstrate the student's information competency.

Assessment and Evaluation

Assessment and evaluation of student learning can be a difficult task for the teacher who uses nontraditional forms of teaching. There are ways of finding out what students learned and what skills they mastered without administering a multiple choice exam or essay test. These assessments take on the form of journals, self-evaluation, observations, and presentations (Carver, 1992).

The students will need a place to jot down their thoughts and ideas as they proceed through their technology learning experience. A technology journal would be an appropriate place to store this information. The journal could include the students' communication of their ideas through written explanations or by drawings. Included in this journal would be other artifacts from the project including a self-evaluation and/or group evaluation sheet.

The teacher could use this journal as a stepping off point for assessment and evaluation of the students' achievement. Additional assessment tools would include tests, informal discussions with the student during hands-on activities with technology, conferences with the student and group members, and observation of the student during the activities, and the production of an end product. The teacher would observe and record the students' technical skills, materials knowledge skills, behavior and communication skills and process skills. All of this information would be collected and reviewed in an anecdotal

report. The teacher would also consider the contents of a student self-evaluation and group evaluation form. By using this variety of assessment tools, the teacher can make a good evaluation of each individual students' achievements (Crook, 1991).

Educational reform is a topic that surrounds every aspect of our school systems. One of the latest reforms called Outcome Based Education (OBE) requires that educators think about what students should know and be able to do by the time they graduate from high school. There is still a group of individuals that continue to push for national testing within content areas as a measure of what learning took place. On the other hand, there are individuals that feel national testing has no place in educational reform and that there is more value in performance based or alternative assessments. All students should be exposed to critical thinking and problem solving opportunities (Mahlke, 1993).

The design technology process has been used successfully in elementary schools across the nation. Through this process, the students identify a problem or question related to the content area they are studying, pose solutions to the problem or question, research or design solutions, and then finally present their findings in a tangible format whether it be a model or software presentation (Bergin, 1993).

What better way to assess students to see what they can do than to have them actually do something? Individual or group outcomes are evident in the ability of the student or group to explain how the solution resolves the problem or question.

Assessment is no longer boiled down to a multiple-choice test where a lucky guess might provide the right answer. The teacher will be able to determine who knows how to solve the problem and who does not with this alternative assessment.

This design technology process is a perfect example of authentic assessment. In the 1992 ASCD publication, A Practical Guide to Alternative Assessment, Herman, Aschnacher, and Winters state that alternative assessment must: (1) accomplish a complex and significant task; (2) utilize prior knowledge; (3) solve and authentic problem; (4) honor the process of learning.

During this process, the students are using prior knowledge. By engaging in research, they are gaining new knowledge. The problems are authentic or real to the students because they come from some aspect of the curriculum, either from literature that they read or from problems they experience or struggle with in other studies (Bereiter, 1984).

The learning process of students have traditionally been assessed using multiple-choice, fill-in-the blank and short answer questions. This leaves the teacher with little information about what led a student to a particular answer. The design technology process is full of opportunities for the students to interact with each other and the teacher. True learning is achieved from the students understanding as to why a particular course was taken. This give and take interaction gives the student the chance to explain, clarify, and reorder thinking. Students are able to learn from one

another and improve their initial designs and beliefs based on what someone else is doing. For students, the process of design technology is as equally important as the products they create (Mahlke, 1993).

The SCANS report, commissioned by the United States Department of Labor, determined that problem-solving skills are the key ingredient for a worker in the twenty-first century labor force. The design technology process allows the students to integrate the creative thinking skills of fluency, flexibility, and originality with critical thinking skills. Students who are able to generate many solutions to a problem demonstrate fluency of ideas. Students who are able to approach problems from different viewpoints show flexibility of thinking. Originality occurs when a student designs a unique solution to a problem or question. Elaborate thinkers are those students who design detailed, intricate and complicate solutions to the problem. All of these skills are observable, teachable, and assessable.

Developmentally Appropriate Software

Computers play an increasing role in business, industry, medicine, and even early childhood education. Teachers and administrators have a critical responsibility to evaluate what role the computer should play in early childhood education. They need to decide what types of activities are best suited for the computer and which computer experiences are appropriate and beneficial to young children (Haugland &

Shade, 1988).

The computer can be viewed as an educational tool. Just like a crayon or pencil, the computer can provide a child with a unique way of dealing with information (Kurland & Pea, 1985). Computer software and experiences must be designed around sound developmentally appropriate approaches to learning. Piaget (1970) viewed children as builders of their own intellectual structures or knowledge. Children are capable of walking, speaking, identifying people and objects, and classifying items without any formal instruction. When children actively explore their world, learning takes place. Through the process of assimilation and accommodation, the child acquires and constructs new knowledge. Piaget stated (1971),

If we desire to form individuals capable of inventive thought and of helping the society of tomorrow to achieve progress, then it is clear that an education which is an active discovery of reality is superior to one that consists merely in providing the youth with ...ready-made truths to know with. (p. 259)

A student of Piaget and a professor at the Massachusetts Institute of Technology, Seymour Papert (1980) also supports the notion of developmental learning. He views learning as often a "gradual process of familiarization, of stumbling into puzzlements and resolving them by proposing and testing simple hypotheses in which new problems resemble others already understood" (Lawler, 1982, p.139).

Papert (1980) has related Piaget's developmental appropriate learning theory to children's experiences with computers. According to Papert, children who are given the

opportunity to have discovery-oriented interactions with the computer will be enhancing their learning. He calls these discovery computer environments "microworlds" or "task domains" or "problem spaces" where a "given cognitive mechanism ...can operate effectively". (Lawler, 1982, p.139). In other words, a microworld is a "child -oriented computer experience, where children are in control, acting on software to make events happen rather than relating to predetermined questions and closed-ended problems" (Haugland & Shade, 1988, p.37).

Papert (1980) uses microworlds to teach children mathematical concepts. Using the program called Logo, which he designed, children are able to control the movements of a robot turtle with programming. Clements (1985) studied first graders who spent eighteen weeks working with Logo and concluded that the students demonstrated significant gains in creativity, originality, reflectivity, and metacognition.

There are ten criteria that have emerged that distinguish software as being developmentally appropriate. The following list defines these criteria (Haugland & Shade, 1988):

1. Age appropriateness. The presentation of concepts and content area reflect realistic expectations for the children.
2. Child control. The software requires active rather than passive involvement from the child. The pace is set by the child, not the program. The children initiate which direction to go, they decide the sequence of events rather than react or respond to predetermined activities. The

software screens are designed so that a child could escape to the main menu from any portion of the program.

3. Clear instructions. Instructions should be written at a developmentally appropriate level so that the child will not have difficulty reading them. Since many children have not mastered the skill of reading, spoken directions should be included. Directions are written in a simple and precise manner. Graphics are associated with choices to make different option apparent to children.

4. Expanding complexity. The entry level of the software should be low. The children should be able to successfully navigate and use the software. The learning sequence is clear as one concept follows the next. As children continue to explore, the software complexity expands which helps the children build structure and knowledge, gaining "powerful ideas of intellectual skills" (Papert, 1980, p.204).

5. Independent exploration. The child is able to maneuver around the software without adult supervision, after a brief initial exposure time period.

6. Process orientation. The process of using the software becomes so engaging, that the product is almost unnoticeable. The discovery of new information rather than drill and practice skills is the true way that children learn, understand, and retain information. Papert (1980) believes that motivation is intrinsic, not the result of rewards and other reinforcement processes.

7. Real world representation. The software is able to

follow a real world model. This allows the children to relate to concrete objects and their functions.

8. Technical features. The software is pleasing to look at and includes many colorful, uncluttered, animated graphics. There is sound and music that relates to different objects on the screen. The software runs fast enough so that there is no idle time for the child to lose interest.

9. Trial and error. The software is designed so that the child can test alternative responses. Children build structures and knowledge by working through a problem, resolving errors, or solving puzzles.

10. Visible transformations. Through children's responses, they are able to have an impact on the software, changing objects and situations from their responses. The process of cause and effect can also be presented on a computer that might otherwise be difficult to view during daily living.

There are many different types of commercial software products for young children which have pleasing graphics and appealing sound effects. However, when these software packages are evaluated for developmental appropriateness using the ten criteria, many of them fail in their approach to teaching and learning. Many teachers who are opposed to drill and practice activities out of workbooks and the likes find themselves using drill and practice software to supplement their curriculum because it is the most prevalent software on the market. Software should not be used in early childhood education just because it allows the students the

opportunity to use the computer. Software should be selected just like all other curriculum resources, to reflect the teaching philosophy of the teacher and that which contains sound developmental approaches to learning (Rowe, 1993).

Effective Multimedia Presentations

The use of multimedia can help students acquire and use knowledge. Multimedia can improve student access to knowledge, uncover ideas, show an interconnectedness between subjects, encourage integrative thought, and finally serve as a powerful presentation tool (Franklin, 1990).

Most knowledge sources emphasize the retrieval of information. The library card catalog is a prime example of this type of source. It offers very little assistance to those who do not have an author's name, title, or subject. On the other hand, multimedia tools allow and encourage the user to browse and begin discovering new concepts or information on his or her own. The user can browse through pictures, movies, and graphic information. Once an area of interest is discovered, the user can then pull up the full text of the printed information and read it for more depth of understanding.

Multimedia is also a wonderful tool for connecting students with a teachable moment. A teachable moment is when students, under their own power, want to learn something. With hypermedia and hyperlinks the students can quickly find out more information by clicking on a button. The button

will take the users to a related area on the topic or to an area that goes into more depth and detail of information. Once the users have obtained enough information, they may continue to explore related ideas or spiral outwards or even return to the point where they left from. A well designed multimedia program takes the teachable moment and builds upon it.

The third area that the use of multimedia is extremely effective in is showing connections between different subjects. Knowledge is interrelated. A multimedia stack on space could related the subject areas of math, language arts, science, art, and history all into one compact package. The key in authoring such a software is tying it all together and unifying the topics. All knowledge is interwoven.

Multimedia can also help the students integrate knowledge. The use of linking concepts to each other is a central function of multimedia. As users begin to link newly learned knowledge with previously gained knowledge learning becomes less abstract and more meaningful. This type of instructions may create a love of learning because the users are discovering new knowledge on their own.

The final use of multimedia is as a presentation tool. The students of today are extremely sophisticated when it comes to understanding media. The students can create and produce their own media products through the use of a multimedia software program.

CHAPTER THREE

Astronomy Unit Curriculum Objectives

The main goal of this M.A. project is to develop a student-centered astronomy curricular unit, designed to teach elementary students about the relationship between the Earth, sun, moon, and solar system through computer assisted technology, information literacy skills and hands-on activities. In terms of cognitive skills, upon completion of the astronomy unit, the students will be able to:

1. describe how the Earth, sun and moon move
2. explain the difference between rotation and revolution
3. explain how distance can affect the size of an object
4. explain how solar and lunar eclipses occur
5. describe why the moon looks different during each part of the month
6. explain what gravity is and describe what happens when there is no gravity
7. determine why the Earth has different seasons
8. build several models to demonstrate how the previously mentioned scientific concepts occur
9. acquire information literacy skills for the 21st century.
10. demonstrate communication skills through written, verbal, and multimedia software expression

11. apply problem solving skills
12. work cooperatively with a group of students

Astronomy Unit Curriculum Goals

The astronomy unit will allow teachers to achieve the following goals:

1. meet one of the science curriculum standards for third grade.
2. show the integration of technology education with the base curriculum.
3. reinforce science, math, and language arts subject areas.
4. provide experiences that allow students to make the connection between the classroom and the real world.
5. introduce the astronomy strand of the science curriculum.
6. provide some of the key communication tools that will be required of the students in the 21st century.
7. incorporate the use of technology into a project-based unit.

CHAPTER FOUR

Design and Development of the Project

Description of the Astronomy Unit

This project consists of two parts: (1) an astronomy unit plan that encompasses the science concepts of the relationship of the Earth, moon, and sun; (2) software that was developed specifically for this unit plan which reinforces the science concepts presented in the lessons.

The unit plan incorporates two main approaches to teaching the concepts at hand. The first approach is guided discovery in which the teacher acts as a facilitator and help or guides the student's learning. The second approach is that of information literacy in which the students will explore text and electronic information and attempt to find answers to the questions they posed at the beginning of the unit. Through the use of exploration and problem solving skills the students will construct their own knowledge. This unit was developed as a third grade astronomy unit to be implemented in an elementary school setting.

Prerequisite Skills

As prerequisites, the students should have a working knowledge of basic computer operations. This would include being able to turn the computer on, access specific software applications, and print any information to a printer. They must also be able to perform basic communication skills which include the ability to express themselves verbally and in

written form. The students must be able to be able to read at a third grade level. Students who have difficulty with reading at grade level or those students who do not have English as their primary language will be paired with students who are able to read at the prerequisite level.

The content area that will be delivered in this unit is at an introductory level. Therefore, prior knowledge about the solar system or the relationship between the sun, moon and Earth is not required. The natural curiosities of students at this age is an important motivating factor in keeping the interest level high during this unit.

Classroom Set-up

Teaching the astronomy unit in the classroom involves dividing the different topic areas into sections. Each section will be presented in a group instruction format by the teacher and then an open discussion session will be provided in which the students can freely question or discuss topics of interest related to the lesson. Hands-on activities will also be included in some of the lessons to help the students discover and retain new knowledge.

A needs analysis is conducted at the beginning of each lesson in which the students write down questions that they have about a particular topic related to the subject. These questions will then be the beginning point of the student's search to find the answer using information literacy skills. Students with like questions will be grouped together and work as a team on solving the problem or finding an answer to

their questions.

The hands-on activities are designed for four students working together to complete certain activities on the computer or in building a model of a concept. Students will be required to work cooperatively using self-paced instruction to complete assigned learning tasks. Each group is responsible for completing the requirements set out by the teacher. The science unit is designed to cover a six week time period in which the students are introduced to some of the basic concepts of astronomy.

Computer Lab Set-up

The computer lab set-up in which the software was tested consists of a separate room from the classroom which is shared by all students at East Heritage Elementary School. The lab contains 32 Power Macintosh 5400/120 computers, a laser printer, a color ink printer, and three dot matrix printers. Each computer has an internet connection using Netscape 3.0 as the browser.

A two-hour time block is reserved by the teacher each week for the students to work on research and information gathering. Additional time is available during the week if needed. In addition to the computers in the lab, there is a stand alone computer in the classroom with the same capabilities as the computers in the lab. Students may access that computer during the regular course of the day.

Teacher's Role

Throughout this science unit, the teacher acts as a facilitator or guide providing assistance every step of the way. It is not the teacher's role to disseminate information and give answers to the student's questions. If a group of students have a question or cannot solve a problem the teacher offers suggestions as to how that information can be found or possible areas to explore to solve the problem. The answer should be discovered by the students, not easily given by the teacher. Students are taught to think on their own using critical thinking skills and collaboration.

Scope of the Astronomy Unit

This astronomy unit covers the same content areas as those developed in the California State Science Framework. The unit itself is a collection of activities that address multiple goals and objectives. The skills of information literacy will be introduced to the students in conjunction with the scientific concepts.

The overall subject matter that is covered in this science unit is mainly concerned with the interrelationships among Earth, the sun, and the moon. The students will learn that the positions and motions of the astronomical bodies influence daily and seasonal changes. The entire solar system and all the other planets are briefly introduced. There are nine sub-concepts of information identified in the instructional format. These include:

- 1) The sun is the principal source of Earth's energy.

- 2) The tilt of the Earth on its axis and its revolution around the sun cause seasonal changes and variations in the length of daylight periods.
- 3) The relative position of Earth, the sun, and the moon produce the cycle of moon phases and eclipses.
- 4) Moonlight is simply reflected sunlight.
- 5) All planets in the solar system orbit the sun.
- 6) The sun belongs to a large mass of stars called the Milky Way galaxy.
- 7) Astronomers study astronomical objects to learn about their movement, distance, and their relationship to other objects as well as their size, mass, shape, composition, temperature, and other conditions.
- 8) By recording daily changes in astronomical events, we can determine long-term patterns of change.
- 9) Models are used to explain the motion of the stars, planets, and other astronomical bodies.

Audience

The learners in this study are students in the third grade whose ages can range anywhere from seven to ten years old. Introduction to the solar system, particularly the Earth, moon, and sun relationships makes up a large portion of the science curriculum for this grade level. It is highly unlikely that students at this age have acquired sophisticated scientific vocabulary. Many students at this grade level have not mastered fluent reading skills and continue to decode simple words. Reading comprehension can

be very difficult for the student if the text is written or spoken at a level that is beyond his or her comprehension.

Most material up to this point in the student's schooling experience has been presented in a concrete fashion. Many students will have considerable difficulty in understanding abstract concepts such as those presented in this science unit. Third grade is an important time in the development of a child's ability and this can be the pivotal year in which some children's development may allow them to "go beyond" and experience learning at a more complex level. This higher level of thinking is required for the students to use information literacy skills.

This science unit is designed to take into consideration today's learner who can have many different needs or styles of learning. The mixture of students in the classroom can consist of students that have learning difficulties, students that are gifted and need to be challenged, students that are acquiring English proficiency, and others that are primarily tactile/kinesthetic, visual or auditory learners. The purpose of this unit is to relay useful and pertinent information that the student can easily work with and learn from.

Structure of the Astronomy Unit

This unit contains ten sections. They are: rotation and revolution, day and night, size and distance, shadows, moon phases, gravity, seasons, solar system, and information literacy. At the start of every lesson, the students will be

asked a series of essential questions by the teacher to simulate curiosity or interest. The unit plan can be found in Appendix B. These questions are designed so that the students can think about what the sun, Earth, and moon are and how they move. Possible misconceptions may be clarified by other students' understandings. Additional student questions may arise from the discussions. After the discussion is completed the teacher then has the students write down the question(s) that they still do not have answers to in their journal. This journal will be a crucial part of the science unit as it will contain the essential questions, thoughts of the student and group, and information literacy processes. It will also be used by the teacher as an assessment tool to evaluate student progress. The students are given a sheet to draw what the moon looks like each night for a month. This information will be used during a later lesson. The amount of class time required to complete this section is one day.

The second section involves the introduction of the concepts of rotation and revolution or more simply put how the Earth moves. The students will be asked to draw in their journals what they think the Earth, sun and moon look like. They will be required to add arrows to the drawings to show in which direction each moves. These student drawings will not be assessed for correctness but as a tool for determining their current understanding of the movement of these objects. The students will be referring to these drawings after they complete a hands-on activity in which they build a model of

the Earth and sun out of a styrofoam ball and a flashlight to determine why there is day and night . The timetable to complete this section is five days.

The third section introduces the concept of scale and structure in which the students will learn that distance can affect the size of an object. Students will learn that the distance from Earth of the sun and the moon cause them to appear to be the same size when viewed from Earth. Even though the sun and the moon appear to be the same size, the sun is much larger. The sun is just farther away from Earth than the moon. The students will complete a hands-on activity using three different sized styrofoam balls and a tape measure to build a model of why objects of different sizes may appear to be the same size. The timetable to complete this section is five days.

The fourth section in the science unit introduces the concept of shadows. This relates to the introduction on the concept of lunar and solar eclipses both partial and total. The students are asked some essential questions such as what is needed to form a shadow, why are some shadows larger than others, do all objects cast shadows, and what three things are required to create a shadow. Another hands-on activity is completed by the students in which they build a model to find out what happens when the moon moves between the sun and the Earth. The students will also discover what happens when the Earth moves between the sun and the moon. The timetable to complete this section is five days.

The fifth section of this unit deals with the concepts

of why the moon appears to change in the sky. The students will use the sheets that were given to them at the beginning of the unit in which they recorded what the moon looked like each night of the month. The concept of keeping track of time and the calendar will be introduced during this section. The timetable to complete this section is three days.

The sixth section introduces the concept of how the Earth and moon are different, specifically with the topic of gravity. The other differences such as lack of air and water will be discussed, but the main focus will be on gravity, what it is and how it affects our daily life. The timetable to complete this section is two days.

The seventh section introduces the concept of why there are seasons on the planet Earth. It incorporates the concepts of distance from the sun and revolution. The students will determine what causes it to be warmer in the summer than in the winter. A hands-on activity using graph paper and a flashlight will help the students understanding of the concept. The timetable to complete this section is three days.

The eighth section in the unit introduces the students to the solar system. The students have just learned about a smaller system which is created by the relationship between the Earth, moon, and sun. Now they will learn that these objects are part of an even larger system called the solar system. The sun is at the center of this system with nine planets revolving around it. Many of these planets have several of their own moons revolving around just like planet

Earth. There are other large and small objects in the solar system like comets, asteroids, and space dust. The students will learn that our solar system is part of another greater system called the Milky Way Galaxy. The timetable to complete this section is two days.

The ninth section of the unit is for the students to explore the Space Encounter software that was developed by the author. This piece of software will provide the students with information that reinforces the learning that took place in the classroom as well as give the students a connection to the internet. This additional information source ties into the information literacy component of the project. The author-created software is but one source of information to be used by the students to complete their quest of finding an answer to the question(s) that they posed at the beginning of the process. Details of the design and development of the software are given in the section titled: "Space Encounter Software (SES): Content, Design, and Development." The timetable to complete this section is two days.

The tenth section of the unit incorporates the skills of information literacy which were discussed in Chapter Two with the science concepts that were presented in the lessons. During all of the sections of this curriculum project, students have been adding information to their journals that they obtained from the SES, internet, textbooks or CD-ROM programs. This information could be additional questions that they have about a concept that was presented, areas that they would like to explore in more depth, or general comments

about concepts that were learned. Students will then be grouped by the teacher based on like questions. The groups' objective will be to answer the questions that they as a group posed. Detailed objectives and lesson plans about information literacy provide the students with the information processing and retrieval skills that they will need to master to become successful citizens in the twenty-first century (see Appendix C).

As a culminating activity, the group will be required to present their findings in a final presentation to the class in the form of a multimedia presentation. These presentations will be evaluated by the teacher as well as other classmates. Specific guidelines will be given to the students as to what elements must be present in their presentation. These student created stacks could be attached to the author's original stacks in the Space Encounter software, building an even greater information resource for future students. The student-centered philosophy of constructivism is prevalent throughout all the activities in this science unit.

Student Assessment

The students are assessed in many different ways during the course of this curriculum unit. Authentic assessment through student journal entries, drawings, sketches, group participation, and the final presentation will give the teacher an overall view of the amount of learning that took

place during the course of the unit. An assessment is embedded in each of the lessons.

Portfolios of student work is an important assessment tool in this unit. The portfolio pieces are student selected, and these pieces provide an opportunity to holistically assess student understanding and progress. Any product of student work related to the subject matter can be included in the student's portfolio. This work may include activity reports, experiment designs, creative writing, team work, observations, or even experiment results.

Space Encounter Software: Content, Design, and Development

A key component of the astronomy unit is the integration of the author-created software (SES). The software is available on a Zip cartridge (see Appendix D). The purpose of the SES is to reinforce the lessons that were taught during the science unit and to use technology as the delivery medium for instruction. It is also an additional information resource to be used in conjunction with other resources such as the internet, CD-ROM software (Space Adventure), textbooks, encyclopedias, and any other information the students can locate. In order for the students to begin to understand these vast concepts, the objectives must be broken down into smaller sub tasks (see Appendix E).

The SES contains twelve information sections on two separate menus. Included in the multimedia features of SES are a variety of digitized pictures, video segments, and

illustrations. These media elements were used in the SES under the Fair Use Act (1992), which allows for the reproduction of copyrighted material for educational use. Sources of these works are noted in the credits section located in the main menu. A listing of copyrighted materials used in this software is provided in Appendix K. In addition to the movies, and other images, the users may access the internet at anytime by clicking on the world icon located at the bottom of the screen. This action will connect the users to the science home page on the internet which was written by the author. Automatic links to a variety of space related topics are available to the users to explore and find answers to their questions.

The opening screen is the title screen. This introduces the user to the program, displays the purpose of the multimedia software and credits the author. Graphics and sound are included to stimulate interest and set the mood. From this screen, the user can click on the right arrow button to advance to the next screen which is the main navigational menu titled: "Main Menu".

The "Main Menu" is the program's "home card" and allows the user to access the main sections of the SES. Each screen within the SES is called a card, and each section on the main menu is a collection of cards called a stack (see Figures 1 and 2). From the two main menus the user can choose to investigate any of the twelve information sections: rotation, revolution, night and day, near and far, solar eclipses, lunar eclipses, gravity, solar system, seasons, moons, moon

Figure 1. First portion of the Main Menu.

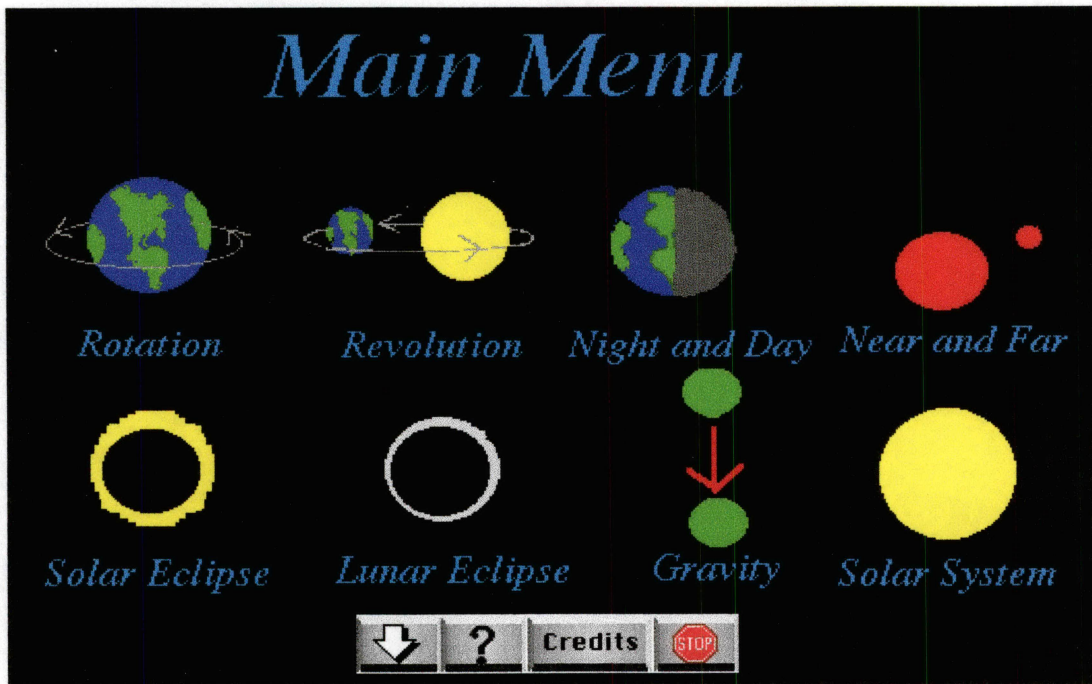


Figure 2. Second portion of the Main Menu.



phases, and stars. The seasons, moons, moon phases, and stars stacks located on the second half of the menu will be developed in the future. They currently contain a card which states that the stack is "Under Construction". There are four blank areas called "New Item" which the author placed on this portion of the menu to allow student-created stacks to be added in the future. The author used graphically familiar icons with titles to depict sections on the menus that could be selected. The user can jump and skip around the menus and select areas of interest. There is no set pattern or direction that the user must keep in mind while using the software. The icons are located on the menu in the same order as the lessons are presented in the astronomy unit.

The software offers an alternative to traditional textbook instruction. The user is provided with high-resolution color photographs, graphics, and motion pictures that are accompanied by brief textual descriptions. These visuals help motivate the learners by increasing their interest of the text. The text is written in a developmentally appropriate fashion to convey information in small chunks.

The "Rotation" section can be accessed by "clicking" on the rotation icon or button which is identified by an illustration of the Earth with an arrow. "Clicking" refers to the user placing the navigational icon on the desired section. The navigational icon is moved by the interaction of the user with the mouse. Once the desired section is located, the user depresses the button on the mouse and the

software automatically advances the user to a different stack. A sound is attached to each movement button so the users can determine whether or not they depressed the mouse button with sufficient force. This sound is consistent throughout all the stacks in this software. The first card of every section contains a photograph that relates to the topic at hand in some manner as well as a title and navigation buttons.

The "Rotation" icon of the Earth with arrows going around it is the first section of the SES. This part of the software presents a short animation of the Earth rotating on its axis. This same animation is shown in the Night and Day section. The concept of the Earth spinning on its axis is introduced in this section. Users also can view a movie of satellites rotating in space to help in their understanding of how the Earth rotates.

Using animation, the next section presents the concept of revolution. Rotation is not the only way that the Earth moves. As it rotates, it is also revolving around the sun. During the animation, the user is shown how the Earth moves completely around the sun and that one revolution is called one year. A table displays the actual number of days that each of the nine planets takes to make one complete revolution around the sun. A section is added where the users are asked to determine how old they would be if they lived on a different planet. In addition to the animation and chart, a simple quiz is given as an anticipatory set to the next concept.

A picture of the moon is shown and the question is, "Do you know what revolves around the Earth?" There are four possible answers to select from: sun, Mars, moon, and Venus. If the users select the correct answer, the software automatically moves them to the next card where they can view a simple animation of the moon revolving around the Earth.

The "Night and Day" icon of the Earth halfway in darkness is the next section in the SES. This portion of the stack includes information about how sunlight covers only one half of the Earth at a time. As Earth rotates, the sun's rays shine on different parts of the world. This is an introductory reason to why there is night and day. The stack incorporates a digitized animation of the Earth rotating on its axis with the sun shining on a portion of it which the user can stop and start by using the movie controller. This stack is related to the rotation stack.

The "Near and Far" icon of a large red ball and a small red ball is the next section of the SES. In this part of the program, the user can investigate the following: distance causes objects to appear smaller than they really are, video of a satellite approaching different planets, and a Thinking Journal where the users can type in their thoughts about a writing prompt.

The next section that the users see is the "Solar Eclipse" icon. If the users choose to explore this area they will see digitized photographs of actual solar eclipses as well as drawings of models depicting how a solar eclipse occurs. There is a short quiz which shows the users two

different positions of the Earth, moon, and sun. The users are to pick which position the three objects need to be located for a solar eclipse to occur. A correct response will produce an applause sound and an incorrect response will create the sound of breaking glass.

The next section the user will see is the icon of the "Lunar Eclipse". This stack was not fully developed for this project. The author would have included similar information as that found in the solar eclipse section with mention of the fact that the Earth and moon need to switch positions for a lunar eclipse to occur. This is also an area that students could add information if they so desired.

The next section of the SES is "Gravity". In this section the users are informed that the Earth and moon are different in many ways, the main difference being gravity. Gravity is defined and an animation is available in which the users can click on the filmstrip icon and apples will fall from an apple tree. This process can be repeated several times until the users are familiar with the concept of gravity. There are two video clips that may be viewed to show the effect of gravity on the moon and the effect of zero gravity in outer space. The users are informed that the moon's gravity is one-sixth that of the Earth's. There is a simple card that asks the users to calculate how much they would weigh on the moon by dividing their Earth weight by six.

The solar system section can be viewed in one of two ways: (1) using the planet menu or (2) advancing one card at

a time by clicking on the right arrow key. The solar system section incorporates sound, photographs, and motion pictures. These multimedia effects help to reinforce the content for visual and auditory learners. The purpose of providing the solar system last is to motivate the students to continue to learn more. The author observed in the classroom setting that the nine planets that make up the solar system or anything remotely related to the solar system are topics of extreme interest amongst third grade students.

The user must click on the down arrow to go to the second half of the menu. It consists of four labeled sections and four blank sections. The "Seasons" icon is the first section on the second half of the menu. If users should click on the tree icon which relates to seasons, they would see a card which states that, "This Stack in Under Construction". This card has a button on it that returns the user back to where they came from. This stack would be related to the "Revolution" stack.

The "Moons", "Moon Phases", and "Stars" icons are similar to the "Seasons" icon. These stacks will be developed in the future by the teacher. Students could construct their own stacks about these topics and attach them to the teacher-created stack.

Finally, there are four blank areas called "New Items" which can be expanded to a separate third menu in the future if new space is needed to display the student-created stacks. These stacks are part of the final requirement in the science unit where the students will present to the class the answer

to their question(s) which they had at the beginning of the process.

Each of the stacks were designed to reinforce information already presented, maintain student interest, and provide motivation for the user to explore each section of the program as well as the internet. The use of technology through this software was incorporated in the astronomy curriculum unit to enhance the learning environment by using all of the multimedia techniques to provide a rich variety of visual and auditory stimuli.

SES Navigation

Navigation through the SES is made possible through the use of two main menus where the users can click on any icon or title and go directly to that part of the program. Once the users are in the selected area they can easily navigate through the stacks by clicking on "buttons". Within the program, the users continue to navigate by clicking on the buttons, which are identified by easily recognizable icons. For example, the internet icon is identified by a small picture of the world. This icon is used to present a visual clue to the content of the area.

Main navigation buttons are placed at the bottom of each card in every section of the program. The left and right arrow buttons take the users to the previous or the next card. The tape cassette button activates the computer voice to read the textual information on that card. The filmstrip button plays animation or movies which are displayed on that

card. The world button connects the users to the internet, specifically the author's science home page. The house button takes the user back home to the main menu. The stop sign button allows the user to quit the program and exit HyperStudio. The same buttons are placed in the exact same location on every card so that the user does not have to relearn navigation techniques each time a new section is explored. The users should be concentrating on the information presented, not on how to get to the next section.

Technology Requirements

The authoring tool that was used in this project is HyperStudio 3.0. Purchasing commercially produced multimedia stacks can be cost prohibitive. Therefore, the use of a multimedia software program can be extremely practical in a school setting especially in the areas of cost and flexibility. All of the schools in the Etiwanda School District have a computer lab with state-of-the-art Power Macintosh or PC type computers. The school where this software was tested is fully capable of running HyperStudio 3.0 on thirty-two computers at one time. Many schools do not have expensive video equipment or other types of authoring tools with which to create teacher-generated instructional materials. A multimedia software program was chosen as the medium in this project because it is readily available, inexpensive, and relatively easy to operate.

There might be some additional "spin-off" benefits to the students and other teachers at this school from being

exposed to a HyperStudio stack. Most teachers and students at this school do not even know what a multimedia stack is, let alone how to run one or program their own. Users may be encouraged to try to write their own programs if enough positive experiences can be gained from the use of this stack. New ideas and formats might be developed if the user can move beyond that initial hurdle and not be too afraid to try new instructional authoring tools. A positive experience with a well written program may be enough of an incentive to motivate others to create their own software.

Additional technology requirements would include a computer with a Zip drive, relatively fast internal processor (120 mhz or faster), internet connection with a minimum of 28.8 baud modem, color monitor, scanner, and a color printer.

Astronomy Unit Instructional Design

The instructional design of the curriculum unit is rooted in the constructivist learning theory. In a constructivist environment, students are encouraged to share their understandings of an idea or concept at the beginning of the discussion of a topic. Through activities and other experiences, teachers may then reinforce acceptable explanations or challenge incorrect or incomplete knowledge. Using these foundations, students have a better chance of assimilating and utilizing new knowledge and constructing new understanding. Students are encouraged to formulate questions and find answers through the use of information

literacy skills (see Appendix C). This is a student-centered science unit which culminates in a final project. Students are allowed to construct science concepts through inquiry and investigation. The two processes of guided discovery and information literacy are melted together in this unit.

Each lesson presented by the teacher is developed using a four-step lesson cycle based on the constructivist philosophy of teaching science. The four steps are: engage, explore, develop, and extend/apply. During the engage activities the students engage in hands-on and minds-on activities that seek to set the stage for the concept to be learned. Minds-on activities are quick, engaging activities that sparks the students' critical thinking about science concepts. In the explore portion of the lesson, the students explore phenomena, attempt to find answers to questions and begin to construct their own understanding of the concept. During the develop process, the results of the explore activity are analyzed and the concept is further developed. Critical connections are made through reading and further activities. The final step in each lesson is the extend/apply portion where students look at the science concept that has been developed and synthesizes and apply this knowledge to new situations and to the world around them. The use of information literacy skills can be actively applied at this point.

Information data gathering will be accomplished is a variety of ways. The materials to be used by the students include a textbook entitled A System in the Sky by Macmillan/

McGraw-Hill, a student journal, various materials for hands-on activities ranging from styrofoam balls to flashlights, resource information including books, encyclopedias, Space Adventure CD-ROM, and the internet. One important source of information will be the author-created software titled Space Encounter which uses multimedia techniques to reinforce the concepts presented in the whole group instruction.

The activities and goals of the project are addressed in full detail in the Structure of the Process section of this chapter.

Software Instructional Design

The instructional design that was used in the stack followed the format of presentation of information with occasional questions to provoke higher levels of thinking. To enable students to actively think about the information being presented and interact with the program at regular intervals, QuickTime movies or animation were given at variable increments so that the users would not become bored. Instruction was presented before a response to a question was required.

To address the developmentally appropriate design of the software, students who have difficulty reading at grade level are able to participate in the usage of the stack because they become active learners as they experience the various levels of instruction. Vocabulary and visual aids help provide linguistic and conceptual support. Through the use of the navigational cassette button, the users are able to have

every card read to them by the computer. Auditory learners will also benefit from the use of the computer reading the information to them rather than these students visually trying to decode each and every word.

Reading strategies are implemented to help the students make connections between the new information in the lesson and what they already know. Key vocabulary terms appear in red type when they are first introduced in the textual information. Vocabulary meaning is clearly defined in context section.

The readability level of the textual information was also taken into consideration for the age level of the end user. Textual material was written at a third grade level. Several vocabulary words were introduced with definitions or explanations attached.

The effective use of multimedia with illustrations, graphics, videos, sounds and photographs are an integral part of the stacks. These visuals are used together with written text to help broaden the student's understanding of important concepts as well as keep the student's interest at a high level.

It is not an easy task to come up with an instructional strategy that will encompass all that the learner needs. However, every attempt has been made to incorporate the necessary material in the most effective manner.

Screen Design

A well-thought out screen design was critical for this program to be effective since the end user has limited computer and mouse experience. The stacks have navigation buttons that are easily identified by the use of picture metaphors. Each screen was carefully created to have the navigation buttons in exactly the same location so as to not confuse the user. Ease in navigation was a primary concern in developing the screens in order to lower or eliminate the frustration level of the user.

The majority of informational cards use a similar layout. This layout consists of a black background which is a metaphor for the blackness of space. A picture or movie is located on the left and textual information on the right. The navigation buttons are always located at the center bottom portion of the card. There is enough black space on each card so as to make it pleasing for the eye to follow and view. Each card was thoughtfully designed to give precisely enough information to the user. Careful consideration was given to avoid cluttering the cards with too much information or providing too little information. Eye movement patterns were also incorporated in the design of the cards. According to research, viewers usually begin looking at the upper left hand corner of the screen and make a sweeping arc with their eyes to the lower right corner of the screen. All of these factors were considered while developing each card.

There were brightly colored pictures, movies, and graphics incorporated in the stacks to keep the users

interested and motivated to learn. The author tried to limit the number of major colors on a card to four. The background on all cards is black which represents the vastness and color of space. Black was also chosen as the background color because it is a neutral or soothing color which will not cause the eyes to become tired. Space was used freely and information was placed so that it followed the normal eye movement.

Formative Evaluation of the Astronomy Unit Curriculum

To assess the potential effectiveness of the Astronomy Unit Curriculum, a questionnaire was developed to evaluate the structure and depth of the curriculum project (see Appendix F). The curriculum evaluation was completed by two elementary school teachers who teach at the same school as the curriculum author. These teachers are in a self-contained third grade classroom and they are required to teach all subjects. The majority of students at this school come from middle class households.

Results of Astronomy Unit Curriculum Evaluation

The overall results of the curriculum questionnaire were favorable. Both of the teachers felt that the hands-on activities were appropriate for third grade students to handle. These teachers also commented that the student involved activities would help students gain and retain new knowledge about the concepts presented. One teacher reported

that the lessons were easy to follow and could be attained within the time allotted. It was also noted that the integration of different curricular areas such as language arts and math were important components of the curriculum unit.

Both teachers commented that the main concern about the curriculum unit was the implementation of the information literacy component. They were not sure that third grade students were developmentally capable of becoming informational literate. They did admit that these concerns stemmed from the fact that the internet and electronic communication were new to them as teachers as well as to the students. Their fears were that they would not be able to teach this section of the curriculum because of their own lack of knowledge in the area.

Formative Evaluation of the Space Encounter Software

To assess the potential effectiveness of the Space Encounter software, a questionnaire was developed (see Appendix G). Eleven third grade students were chosen at random to preview the software and answer the questionnaire about the design, format and content presented in the multimedia stacks. Once the students were selected, they were given a consent form to be signed by their parents and by themselves. The consent form explained what the project was about, that participation was strictly voluntary, and that consent could be withdrawn at anytime (see Appendix H).

Only those students that returned the required consent form were allowed to participate in the testing and questionnaire process. All eleven students that were chosen returned their consent form the next day and the testing process began.

It should be noted that this school's computer lab and classrooms were not officially connected to the internet at the time of testing. The stacks all contain an internet connectivity button that once clicked takes the user to the author's science home page which lists several hyperlinks to space related sites. The computer in the author's classroom was connected to the internet through an external modem. Many of the students were able to come back to the classroom after completing the software review in the computer lab and explore this portion of the software.

Evaluators

This project was evaluated by eleven third grade students and two teachers. One-half of the third grade students were age eight and the other half were age nine. Of the eleven students, six were male and five were female. Ten of the eleven students indicated that English was their primary language and one student replied that Phillipino was his primary language.

Two teachers were also involved in the testing process. One teacher who teaches third grade is age 33 and the other teacher who teaches fourth grade is 45. Both teachers are female and indicated that English was their primary language.

Procedure

The investigator preloaded the software onto the hard drives of ten Power Macintosh 5400/120 computers in the computer lab at the school. The original software is located on a Zip cartridge because of its large size (35 MB). The school does not own a Zip Drive so it was necessary for the investigator to borrow a Zip Drive from the Computing and Media Center at California State University, San Bernardino. The investigator then installed the Zip Drive on one computer at a time and downloaded the stacks, sound files, QuickTime movies, and graphics into a folder called Space Encounter.

All evaluators had access to their own computer and were instructed to place the headphones on their head. The students were not separated from each other but were sitting next to each other. The only instructions that the investigator gave the group of evaluators was to click on the stack titled "Start Here". The evaluators were given forty minutes to view the software and interact with the various multimedia selections.

Upon completing the program, the evaluators were given a questionnaire and a pencil and asked to give honest answers to the fifteen questions on the questionnaire (see Appendix G). Some of the questions that were asked included: what the students liked and disliked about the software, did they have any problems using the software, did they like the pictures, movies, and drawings.

Student Feedback Received

The overall results of the software by the students was favorable. The individual results of the feedback can be viewed at Appendix I. While observing the students the investigator noticed that the students thoroughly enjoyed viewing the movies and telling other students where to find the movies in the stacks. It appeared that a few students searched all the stacks and viewed all of the movies before reading the information. Once all the movies were viewed, these students returned to the main menu and began going through each stack, card by card. It appeared that even though the students were sitting in front of their own computer, they enjoyed interacting with the student to either side of them. The investigator observed the students sharing ideas, developing their own observations, and enjoying their new found knowledge with others. The investigator also observed that there were no problems with the navigation process. The students clicked upon the navigational buttons with ease.

The students seemed to like the motion pictures, colorful photographs and sounds the best. They did not like the Thinking Journal, the fact that the movies went too slowly, and that there were no games to play. Some of the students indicated that they did not like the computer voice because it was too slow. Only one problem was encountered during the review process and that was in the Mars section. One button was not correctly linked to the proper card. The investigator took note of this fact and made changes at a

later time.

All eleven students found the directions easy to follow, and enjoyed the pictures, movies and drawings. The reading level was too easy for two students and just right for nine students. Most of the students found the reading to be interesting and all of the students had the computer read at least one section to them. Seven of the eleven students did not like the speed of the computer voice. They felt that it was too slow.

All eleven students enjoyed viewing the program and felt that they had learned something. All of the students felt that looking at the software was more fun than reading the information straight from a book.

Finally, the students made the following comments on the questionnaire. "I think it was very educational. I loved the program. If it is not on every computer, it should be. This should be a science unit in our curriculum." "I liked the movies and I didn't like the games they didn't let us play with. My favorite movie was when the satellites rotate." "I want to know how many stars are in the sky." Typical comments also included: "I liked it" and "it was fun". It was apparent that the students enjoyed viewing the program.

Teacher Feedback Received

Two teachers reviewed the software as well. Their comments were positive and informative. Most of their comments were very close to those comments made by the students with a few exceptions (see Appendix I). The

teachers all felt that the reading level was just right for third grade students. The teachers also felt that the content of the reading was informative while the students felt the reading was interesting.

The teachers themselves learned a few new things from viewing the software. They felt that the navigation was easy to follow. Some of the comments were: "The sounds were great." "It was very easy to use and follow." "The filmstrip movies were great!" "I like how the text was written to click on a video. This way I didn't miss anything." The teachers' response to the software was very positive.

Software Revisions Made

Two revisions were made in the stacks as a direct result of the testing. First of all there was a link missing from the Mars planet to the Mars card. The author added that link. Some students had indicated that the computer voice was too slow. The speed of the voice was increased one notch. It is the author's opinion that the computer voice is machine generated and the students are not accustomed to this type of sound. The author did not want to increase the speed of the voice too much because it would be used by students who do not use English as their primary language. As a result, the author made two versions of the same software. One version, the computer speaks at the same speed as the original software, and another version, the computer speaks at a faster rate.

IRB Permission

An Institutional Review Board (IRB) form was submitted to the board at California State University, San Bernardino seeking permission to use human participants in this research. A full board review was requested by the author because the research involved children under the age of seventeen. The IRB form is designed to request written consent for individuals to participate in the evaluation process of this project. The IRB form includes reasons for the development of the software, the procedure involved, voluntary participation, participant's rights, and no risk involvement. The approved IRB form is found in Appendix J.

Strengths of the Astronomy Unit

The astronomy unit curriculum allows the students the opportunity to experience for the first time an introduction to astronomical concepts that they will use for the rest of their lives. Through the use of this curriculum students find out about the system formed by the sun, Earth, and moon. Students are also introduced to careers in this area of science as well as new technology developments. During the course of the astronomy unit the students will also begin to develop the skills of information literacy which will be useful to them in completing future research. Students will also gain experience in working with other students as a team, to complete the task of finding answers to the

questions at hand, and presenting that information to the class. There are many important life skills that are entwined within the content areas of this unit.

Limitations of the Astronomy Unit

There are several limitations to using this astronomy unit. The most crucial limitation is time. Due to the research aspect of this unit, it is entirely possible that the entire class day could be spent investigating and researching possible answers to questions. A large portion of the day would have to be set aside in order to complete some of the activities. Designing and implementing a curriculum of this size requires a great deal of planning and implementing time on the part of the teacher. Teachers already have enough to deal with on a daily basis. Many teachers might be reluctant to take on one more challenge.

Finally, classrooms may not have the technical hardware or software available for use to complete such a unit. Since information literacy skills are an important part of this unit, it is crucial that the students are able to use the internet as a main source of information. Many schools do not have the luxury of this feature available for student use at this time.

Strengths of the Software

The main strength of the SES is the integration of the science process with discovery learning and computer

technology. The use of a multimedia development tool enabled the users to interact with a wide range of information presented in the form of text, photographic-quality pictures, live digitized video, and sound. This caught the interest and stimulated questions for other learners that interacted with the presentations. The fact that students can add to the original stack, change areas in the stack, or create their own stack that is attached to the original presentation allows the user to construct new knowledge. The learner is simply not digesting information that will be regurgitated in a written test at a later date. This type of interactive learning will become part of the student's schema.

Limitations of the Software

The limitation of the software is the scope of the scientific material presented. Five of the twelve stacks remain to be completed. The author chose to develop the most important subject areas first. Ultimately, the software will be expanded by the teacher and/or the students to cover a wider area of the solar system or other space related topics. There is also no formative evaluation on the student-created stacks. Another major limitation was that the computer lab was not connected to the internet at the time of the review process. Students did not receive the full benefit of exploring new areas or other web sites while examining the SES.

Recommendations for Future Projects

A future project in this area would be to expand the use of this learning process into other curricular areas such as social studies, language arts, and math. The information literacy and scientific skills learned in this project can be used in any area of learning.

The author also feels that with the recent introduction of HyperStudio on the internet an exciting project would be to publish student created stacks on the internet to share with other students and teachers. This would allow the students to receive a world-wide audience for their creations with the opportunity to receive feedback and suggestions from that huge audience base. The world would become the students' evaluator, not just the teacher or other classmates.

Concluding Statement

The astronomy unit and the Space Encounter software both have great potential for creating a teaching environment that is rich in both content and visual stimulation. The information literacy skills that can be gained from the unit will be invaluable tools needed by these students to be successful citizens in the next century. At the same time, elementary students can gain new knowledge of the solar system and the relationships between the Earth, sun, and moon. It is the author's intent to build upon the inherent curiosities of young students and provide them with the tools

to seek out answers to their questions. This in turn, will hopefully create life-long learners who never stop gaining new knowledge.

Appendix A: Glossary

Authoring program - Application or program such as HyperStudio that a user can use to create applications (Turner & Land, 1994).

Button - HyperStudio object on the card or background layer that, when clicked, causes some action to take place, depending on the button's script (Wagner, 1995)

Card - The HyperStudio object that is the basic unit or building block of the stack (Wagner, 1995).

CD-ROM - Acronym for compact-disc-read-only-memory (Turner & Land, 1994).

Clip art - A collection of pictures stored electronically (Turner & Land, 1994).

Cognitive Science - The psychological science that attempts to understand the internal processes of behavior and emphasizes knowing rather than responding (Saettler, 1990).

Compact disk - Read-only optical storage medium for all kinds of digital data - text, pictures, music, and video.

Constructivism - Constructivism is concerned with how we construct knowledge from our experiences, mental structures, and beliefs that are used to interpret objects and events (Saettler, 1990).

Digital - Refers to a signal sent and received in discrete intervals or to data presented by two numerals, normally zero and one (Turner & Land, 1994).

Home Card - Home is the starting point in HyperStudio. The first card in a home stack is called a home card (Wagner, 1995).

Home Stack - Usually a menu style stack that has connections to all the other stack on a system (Wagner, 1995).

Hypermedia - Extends the concept of hypertext to include other forms of media, such as pictures, music, digitized audio, and digitized video (Turner & Land, 1994).

Hypertext - Term created in the 1960s by Ted Nelson to refer to an environment in which you can jump around electronically within large amounts of text (Turner & Land, 1994).

Icon - Picture or graphic used to indicate the presence of a button (Wagner, 1995).

Interactive multimedia - Multimedia software in which the user is an active and involved participant (Turner & Land, 1994).

Kilobyte (KB) - One thousand. Actually, in computer terminology, K-1,024 bytes of memory (2 to the tenth power) (Turner & Land, 1994).

Megabyte (MB, meg) - A unit of measurement equal to 1,024 kilobytes, or 1,048,576 bytes, commonly used in specifying the capacity of computer memory or storage (Turner & Land, 1994).

Memory - Storage locations in the computer in RAM or ROM (Saettler, 1990).

Mouse - Input device used to point, select, and drag items (Turner & Land, 1994).

Multimedia - Refers to the integration or a variety of media, such as text, graphics, audio, and video (Saettler, 1990).

Scanner - A device that scans an image and digitizes that image so that a computer can read it.

Stack - A file that contains one or more cards, along with any buttons, graphics, sounds, and other multimedia elements that have been placed on those cards (Wagner, 1995).

Zip Drive - An external disk drive that is capable of storing large amounts of data on a single Zip Diskette. Each Zip Diskette can hold 100MB of data.

Appendix B: Astronomy Unit Plan

Astronomy Unit Plan

Astronomy Unit Plan
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Lesson One - Introductory Lesson

Objective: The students will express what they already know about the Earth, sun, and moon. Students will develop key questions to be answered later on in the science unit using information literacy skills.

Materials: Science Journals, Moon Watch sheet

Step 1: Assessing Prior Knowledge

The teacher asks the students some essential questions:

- What part of the solar system do you know about?
- Does the moon change shape? Does it rise and fall in the sky?
- Where does the sun go at night?
- Does the moon have a face?
- How can earth be round when it looks so flat?
- How do the Earth, moon, and sun move?
- Have you ever thought of any of these questions?
- Do you have some questions of your own? What are they?

Step 2: Discussion

After the students have listened to the questions posed by the teacher or by other students, the teacher encourages the students to discuss their misconceptions.

1. Ask the students to talk about what they know about the sun, Earth, and moon to assess their prior knowledge.
2. Students share their ideas about some of the essential questions.

Step 3: Journal Writing

Once the class discussions are complete, the students are asked to write down any and all questions that they have about the discussion that just took place. Students may write down any questions that they might have that were not answered or any new questions. These questions will be the basis for the information literacy portion of this project. This will be discussed during a later activity.

Step 4: Moon Watch Instructions

The students are given a moon watch calendar sheet which has fourteen circles drawn on it. These empty circles represent the moon on each night of the watch for one-half of the lunar cycle. The students are to color in any part of the moon that they cannot see each night. If it is a cloudy night, the students leave the moon blank for that particular night. Students will use this sheet later on in the unit.

Lesson Two - How Does Earth Move?

Objective: The students will:

- Formulate a model of the sun and Earth movements
- Hypothesize what Earth and the sun do to cause day and night
- Demonstrate how Earth rotates and revolves

Materials: Science Journals

Step 1: Assessing Prior Knowledge

1. The teacher asks some essential questions and allows ample time for discussion:

- Which is larger- the sun or the moon?
- Which is further away from the Earth - the sun or the moon?
- How are the movements of the sun, Earth, and moon related to each other?
- What explanation have you heard to explain the movements of the sun and moon?
- What explanations would you give for the movement of the sun and Earth?
- Is there any way you can tell Earth is moving?

Step 2: Minds-On Drawing Activity

1. The teacher tells each student to take out their Science Journals and delivers the following instructions:

- Try thinking like an astronomer and draw the sun,

Earth, and moon. Draw arrows how you think that each one moves.

Step 3: Assessing Student Drawings

Students' drawing should not be assessed for correctness but as an indication of their current understanding of the sun, Earth, and moon. Students will be referring to their drawings later in the lesson to compare their original understandings with the models that they develop in the next activity.

Lesson Three: Why Is There Day and Night?

Objectives: (1) Formulate a model of the sun and Earth movements (2) Hypothesize what Earth and the sun do to cause day and night

Materials: Science Journals, toothpick, felt pen, flashlight, 3-inch foam ball

Step 1 - Activity:

1. Stick the toothpick just far enough into the foam ball so you can use it as a handle.

2. With the marker, make a dot in the middle of the ball. The ball will be the Earth in your model. The flashlight will be the sun in your model.

3. Hold the flashlight so that the light is shining towards the ceiling. Hold the ball by the toothpick, moving the ball to make light shine on the dot. If the flashlight is the sun and the ball is the Earth, would it be day or night at the dot? Is it day or night on the other side of the ball?

4. With your group, think of two different ways to make day and night at the dot. Write down your ideas in your Science Journal.

Step 2 - Discussion:

1. The teacher poses the following questions to the students and they write their responses in their Science

Journals.

- In the first model, what is moving? How did that movement cause day and night at the dot?
- In the second model, what is moving? How did that movement cause day and night at the dot?
- Imagine that you are standing on the dot. How does the sun's position seem to change from where you are on the dot as you make night happen in each model?

2. Class Discussion - The teacher has the groups share their findings. Different models are compared and the teacher poses the following questions which the student respond to in the discussion as well as in their Science Journals.

- Compare the models your group thought of with the models of the other groups. Determine which is best and explain why.
- Look at the drawings you made at the beginning of this activity about how the sun, Earth, and moon move. Would you change them? How?

Step 3 - Instruction:

The students read a section on rotation and revolution in the student textbook. The teacher and students discuss the illustrations and the differences between these two concepts. These concepts are reviewed in the teacher-created software program called Space Encounter.

Students then draw a new model of rotation and revolution in their Science Journals.

Lesson Four: Can You Trust Your Eyes About Size?

Objectives: The students will:

- Compare the relative sizes and distances of the sun, Earth, and moon
- Infer that the farther away an object is, the smaller the object looks.
- Formulate a model to show the sizes of the sun, Earth, and moon to scale
- Formulate a model to show relative distances between the sun and the Earth, and the moon and the Earth.

Materials: Science Journal

Step 1 - Assessing Prior Knowledge

1. The teacher asks some essential questions and allows ample time for discussion:

- What appears to happen to the size of an object as it moves farther away from you?
- If you were standing on the moon, which would appear larger to you - Earth or sun? Why?

Step 2- Discussion

Have the students relate times they have seen objects that appear larger or smaller than actual size due to distance. Some examples of this would be (1) riding in a car and seeing signs in the distance that can't be read until you get closer, (2) looking down a street and noticing that cars

at the end of the street look smaller than cars right next to you.

Students complete a hands-on experiment in which they build a model of this concept.

Take A Closer Look

Objectives: (1) Compare the relative sizes and distances of the sun, Earth, and moon, (2) Infer that the farther away an object is, the smaller it looks.

Materials: Science Journals, , 1- in. foam ball, 2-in. foam ball, 3-in. foam ball, meter tape or meter stick

Step 1 - Activity:

The sun and moon appear to be the same size in our sky. But one is actually larger. In this activity, you will use a model to explore why they look the same size when they are not.

1. Work in a group of four. Place the balls in a line across a table 10 cm from the edge. Bend down so that your eyes are at table-top level. Look at each of the balls with one eye closed. Compare their sizes. Have each member of your group do this

2. Leave the 1-in. ball where it is. Move the 2-in. ball back on the table until it appears to be the same size as the 1-in. ball. Measure the distance from the table edge to the 2-in. ball. Record this distance in your Science Journal.

3. Repeat step 2 using the 3-in. ball. Have members of your group do a different part of the activity than they did in step 2. Measure and record the distance in your Science Journal.

Step 2 - Discussion:

1. The teacher poses the following questions to the students and they write their responses in their Science Journals.

- What did you observe as each ball moved farther from your eye?
- What did you do to make the 2-in. ball and the 3-in. ball appear to be the same as the 1-in. ball?

In the next hands-on experiment, the students build a model comparing the sizes of the sun, Earth, and moon.

How Big Is Big?

Objective: Compare the sizes of the sun, Earth, and moon by making a model.

Materials: Science journal, piece of paper, meter tape, masking tape.

Activity:

1. In the center of the paper, draw a circle that is 1 cm across. This will be Earth. Now make a circle that is 2.5 mm wide. This is the moon. Then use masking tape to make a circle on the floor that is 100 cm across. This will be the sun. Finally, put the notebook paper next to the circle on

the floor. How do the moon and the Earth compare in size to the sun? How do they compare in size to each other? Record your observations in your Science Journal.

2. Class Discussion - The teacher has the groups share their findings then poses these questions. The students write their responses to these questions in their Science Journal followed by a class discussion.

- How does the moon compare in size with the sun?
- How does Earth compare in size with the sun?
- How do the Earth and moon compare in size with each other?

Lesson Five: Do Earth and The Moon Cast Shadows?

Objectives: (1) Formulate models of solar and lunar eclipses, (2) predict the positions of the sun, moon, and Earth in solar and lunar eclipses

Materials: Science Journals

Step 1: Assessing Prior Knowledge

1. The teacher asks some essential questions and allows ample time for discussion:

- What do you need to form a shadow?
- What do you think would happen if the moon were positioned in a straight line between the sun and the earth?

Step 2: Discussion

After a brief lesson about shadows, the teacher asks the students the following questions. Students record their responses in their Science Journal and then a discussion begins about the possible answers.

- What causes a shadow to form?
- Why are some shadows larger than other shadow?.
- Do all objects cast shadows?
- What three things are necessary for a shadow to form?

Students complete a hands-on experiment to demonstrate the concept of shadows.

Shadow Games in Space

Objective: You already know that the Earth and moon are

parts of a system moving around the sun. In this activity, you will use a model to find out what happens when the moon moves between the sun and the Earth. Then you will discover what happens when Earth moves between the sun and the moon.

Materials: Science Journal, 1-in. foam ball. 3-in foam ball, 2 toothpicks, flashlight, meter tape.

Activity:

1. Push a toothpick into each ball to make it easier to hold.

2. Work in a darkened room.

3. Predict where the light will fall if you hold the smaller ball between the light and the larger ball at a distance of 10 cm from the larger ball. Record your predictions in your Science Journal.

4. Use the model to test your prediction. Record your observations and compare them with your predictions.

5. Predict where the shadow will fall if you repeat the activity holding the larger ball between the light and the smaller ball at a distance of 10 cm from the larger ball. Record your predictions.

6. Use the model to test your predictions. Record your observations and compare them with your predictions.

Discussion/ Questions

Upon completion of the experiments, the students are asked the following questions and they write their responses in their Science Journals. Then a class discussion begins.

- Why did shadows form?
- What does the larger ball represent?
- What does the smaller ball represent?
- What does the light represent?
- What would you see if you were standing at the center of the shadow on the larger ball?

A brief lesson about the differences between a solar and lunar eclipse is given. The teacher also discusses the differences between a partial and a total eclipse and the lining up of the three objects.

Lesson Six: Why Does The Moon Change?

Objectives: (1) Formulate a model to explain why we see moon phases (2) interpret data gathered from the beginning of the unit to predict the moon phases from the observed sequences.

Materials: Science Journal, Moon Watch Sheet

Step 1 - Assessing Prior Knowledge

1. The teacher poses the following questions to the students to assess their prior knowledge.

- Does the moon always appear to be the same shape in the sky? If not, what shapes have you noticed?
- Does the moon actually change its shape every day?
- What makes the moon change shape throughout the month?

This is an area full of student misconceptions. The teacher uses these misconceptions as a springboard into the lesson. Students' misconceptions should be corrected.

Step 2 - Instruction

The moon changes because of patterns of change. Students should be aware of patterns that occur in their daily and weekly lives. The changes of the moon follow similar patterns.

In the next activity, the students will create a model to see how Earth and the moon move together to make patterns.

The Pattern of the Moon

Objective: If you look at the moon every night for a month,

it appears to change shape. In this activity, you'll use a model to find out exactly what happens.

Materials:

Science Journal, 3-in. foam ball half painted black, masking tape, toothpick, marker, scissors, 2 pieces of white construction paper, 1 piece of yellow construction paper.

Activity:

1. Make a sun for your model by cutting a large circle from the yellow construction paper. Tape the sun to the middle of the front wall in your classroom. This will be the location of the sun in your classroom.

2. Cut each of the pieces of the white paper into four equal squares. Label each square with a capital letter. Put A on the first square, B on the second square, and so on. Tape square A right under the sun. Tape square B in the corner of the room to the left of the sun. Continue in that direction, taping squares C, D, and so on in the center of each wall and in each corner. When you finish the squares should be in alphabetical order.

3. In this activity you will be Earth. The black-and-white ball another person will hold will be the moon. Stick the toothpick into the moon anywhere that the black and white meet. Use the toothpick as a handle.

4. Have the person move the moon around Earth(you), always keeping the white side of the moon facing the sun. Observe the moon carefully as it moves around you, turning as

necessary to keep the moon in sight. Observe the shape of the white part of the moon as it passes each piece of white paper.

5. Repeat step 4, changing places so that you are the moon and the other person is Earth. Compare your observations.

6. Create a chart of the Earth and moon positions in your Science Journal. Draw the white part of the moon at each point of the orbit. Answer the following questions in your Science Journal.

- At what point could you see the most of the white part of the moon?
- At what point could you see the least of the white part of the moon?
- Did the moon really change shape?
- Why are we able to see only part of the moon at certain times?

Classroom discussions could begin after the students complete their science journals.

Lesson Seven: Why Are the Earth and Moon Different?

Objectives: learn about the differences between the Earth and the moon, particularly gravity.

Materials: Science Journal

Step 1 - Assessing Students' Prior Knowledge

The teacher poses the following questions to determine the amount of information that the students already possess about the differences between the Earth and the moon.

- Is the moon a ball of fiery gases like the sun?
- What is moonlight?
- Is there life on the moon?
- What is gravity?
- Does the moon have the same gravity as Earth?

Step 2 - Instruction

Since this is a very basic introduction section on the differences of the Earth and the moon, the teacher presents this section in a more traditional manner. Through the use of textual information or videos, the teacher is able to convey the ideas between the differences. The main differences include: lack of air, water, life, and a small gravity fields that is one-sixth that of earth's gravity force. This concept is further reinforced by the SES and two movies present the concept of gravity. There are no hands-on experiments in this section.

Lesson Eight: Are There Reasons For The Seasons?

Objectives: (1) formulate a model of how the sun's rays strike Earth's surface at different times of the year, (2) infer that a location's position relative to the sun's direct rays will help decide the location's season.

Materials: Science Journal, globe, white paper

Step 1 - Assessing Students' Prior Knowledge

The teacher poses the following questions to assess the students' prior knowledge.

- Is Earth closer to the sun in the summer than in winter?
- Are our seasons due to changes in the amount of heat the sun produces?

Step 2 - Instruction

The teacher uses a globe to point out different locations on Earth. The teacher has the students hypothesize as to the number of seasons a place would experience. Normally, if a place is close to the equator, it will experience one or two seasons. As one moves north or south of the equator, a place usually has four seasons. Students may use information literacy skills to research whether or not this is true.

Step 3 - Minds-On Drawing Activity

Students are given a white piece of paper and asked to draw the four seasons that they experience where they live. The paper is folded into fours and the words, winter, spring,

summer, fall are written on the papers. The students draw the appropriate pictures of what each season looks like.

Students' drawings should not be assessed for correctness but for their understanding of seasonal changes in their area.

The students complete a hands-on activity to determine why it is warmer in the summer than in the winter.

Why Is It Warmer In The Summer?

Objective: You already know that it is warmer in the summer than in the winter. Something changes as Earth revolves around the sun. In this activity, you will explore what that change is and what it has to do with seasons.

Materials: Science Journal, graph paper, flashlight

Activity:

1. Work in a darkened room. Put the graph paper on the floor.

2. Sit in a chair and rest your arms on your legs. Hold the flashlight, shining it straight down on the graph paper.

3. Have another person in your group trace the outline of the lighted area on the paper and count the number of squares inside the outlined area. Record your answers in your Science Journal.

4. Hold the flashlight at an angle while still resting it on your knees. Move the paper as necessary to get the light to shine on it.

5. Repeat step 3.

Upon completion of the activity, the students will be asked the following questions. Their responses should be recorded in their Science Journals.

- Which time were there more squares inside the outlined area?
- Did the amount of light coming out of the flashlight change? What was it about the light that changed?
- In which of the outlined areas would an individual square be brighter? Why?
- If the flashlight were the sun, which of the outlined areas do you think would be warmer? Why?

Students participate in a class discussion about the concepts that were just discovered. The concepts of solar energy, north and south poles and the reversal of seasons, and day-light time savings could be discussed here.

Lesson Nine: Your Solar Neighborhood

Objectives: The students become aware that the sun, Earth, and moon are part of a larger system called the Solar System.

Material: None

Activity:

This is an introduction to the solar system and the nine planets. The teacher presents this information using movie, books, or computer software that is available about this topic. This is the jumping off point for the students to explore the SES as well as a focal point to begin developing the essential question(s) that they will attempt to answer.

Appendix C: Information Literacy Objectives and Steps

There are several specific competencies that will be gained in this process. The two main instructional objectives to be learned are that of information problem-solving and using technology to find solutions to the problems. Information literate people are those who have learned how to learn. They know how knowledge is organized, how to find information, and how to use that information to present their ideas. Information literate students are life-long learners because they have obtained the skill of finding information needed to resolve any task or decision that needs to be made. The ability to access and use information is a necessary skill that one must possess to be successful in school, work, and life.

There are seven steps to be achieved in becoming an information literate individual. These steps are outlined in detail in the position paper on information problem solving written in 1994 by the American Association of School Libraries (AASL). The following list of objectives is what the learner will be able to do upon completing this project (AASL paper, 1994):

- Step 1. Define the need for information
- Step 2. Initiate the research strategy
- Step 3. Locate the resources
- Step 4. Assess and comprehend the information
- Step 5. Interpret the information
- Step 6. Communicate the information

Step 7. Evaluate the product and process (p. 2-3)

The first step deals with defining the need for information. The learner will:

1. identify that a need exists to find information and define that need.
2. define a place of reference for the information (who, what, where, when, how, why).
3. relate the needed information to previous knowledge.
4. create the information problem through the use of questioning techniques (i.e. yes/no, open ended).

The second step relates to starting the search strategy. The learner will:

1. determine what information is needed by asking additional questions.
2. brainstorm and organize ideas and thoughts by using advanced organizers techniques such as webbing, outlining, or listing.
3. use a visual organizer that is appropriate for the subject matter.
4. create a list of key words, descriptors, subject headings, or concepts to begin the search with.
5. determine the importance of using more than one source of information.
6. find places of gathering information.
7. decide if the information and format is useful.

The third step relates to finding the resources. It is important at the beginning of research that the student locate information from a variety of sources. The learner

will be able to:

1. locate print, visual, audiovisual, and computerized information from the school library, classroom library, public library, and computer laboratory using bibliographical references and electronic search techniques. The author-created multimedia stack entitled Space Encounters would be a main source of information at this point.

2. use people as a source of information by conducting interviews, letters of inquiry, or electronic mail communication to experts in the area of inquiry.

3. consult with the librarian or teacher to help identify additional sources of information.

4. use internal organizers (i.e. indexes, table of contents, and cross references) to find specific information.

The fourth step relates to understanding the information. The learner will:

1. look for major keywords to determine if the information is relevant.

2. select information which is most closely tied to the individual learner's learning style.

3. revise the original problem or question if necessary.

The fifth step deals with interpreting the information to solve the problem at hand. The learner will:

1. rewrite the information in the students' own words.

2. process the new information and relate it to previous information.

3. compare new information with the original problem and decide if additional information needs to be gathered.

4. arrive at an answer or conclusion based on the gathered information.

The sixth step deals with the ability of the student to communicate the information to an audience. The learner will:

1. identify the format of presentation and the intended audience.

2. select a format that would be appropriate for purpose and audience.

3. create a product (i.e. report, speech, videotape, or for this project a multimedia presentation).

4. document the sources of information.

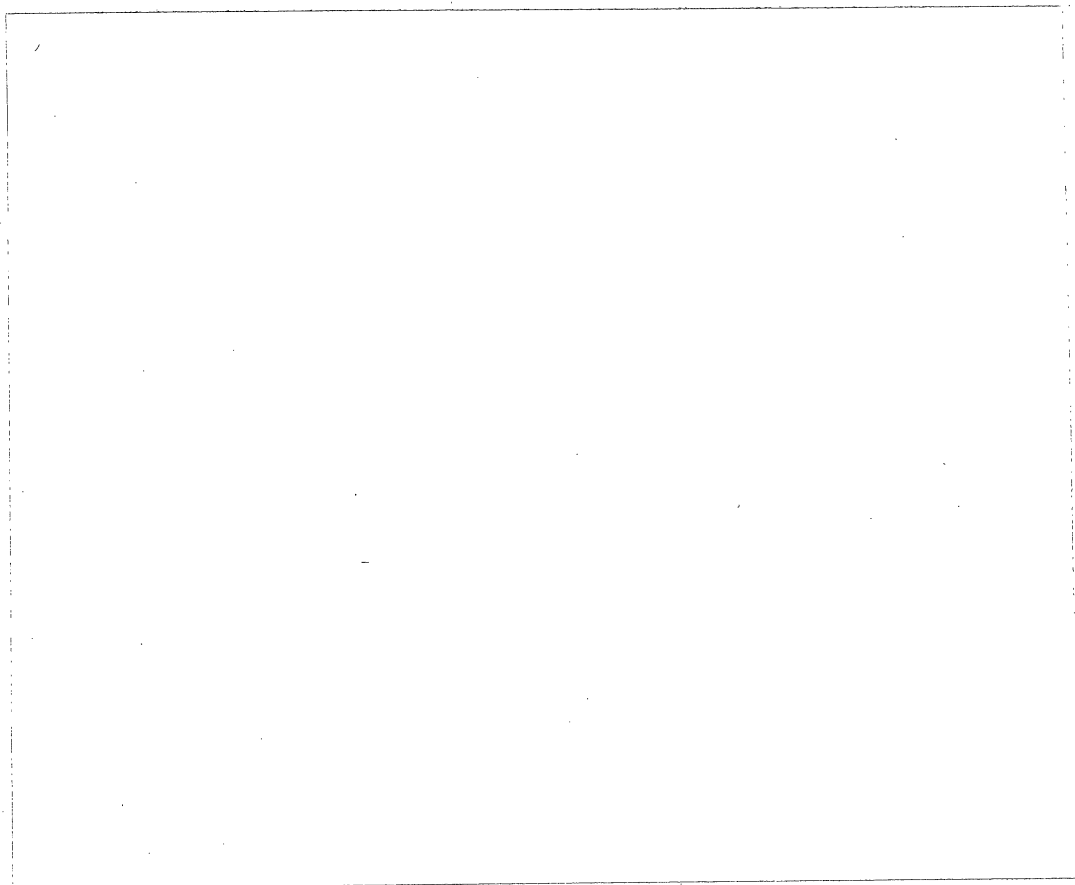
The final step is the evaluation of the product and the process. The learner will:

1. decide if the conclusions or answers meet the information need. Did the student answer the question?

2. decide if the information gathering should have been expanded or revised to meet the information need. Should something have been done differently?

3. determine areas where the process could have been improved, where more practice is needed for further understanding. How could this be improved in the future?

Appendix D: Space Encounter Software



Appendix E: Space Encounter Software Objectives

How Does Earth Move? (Rotation, Revolution and Solar System Stacks):

1) Given a picture of the sun, Earth and moon, the learner will conclude from an on screen model how the sun and Earth move.

2) The students will hypothesize what the Earth and the sun do to cause day and night.

3) The students will conclude that the other eight planets in the solar system revolve around the sun and rotate on their own axis.

The learner outcomes for these objectives will be for the student to explain the relative positions and motions of the sun, Earth moon, and other planets.

Can You Trust Your Eyes About Size? (Near and Far Stack):

1) Given a picture on the screen, the learner will compare the relative sizes and distances of the sun, Earth, and moon .

2) The student will infer that the farther away an object is, the smaller it looks.

The learner outcomes for these objectives will include the ability to demonstrate the relative positions of the sun, Earth, and moon. The learner will also infer that the apparent size of an object depends on its actual size and distance. The learner will conclude that the apparent sizes of the sun and moon are due to the distances from Earth and

not to actual size.

Do Earth and the Moon Cast Shadows? (Solar and Lunar Eclipse Stacks):

1) Given the appropriate pictures, the learner will be able to formulate models of solar and lunar eclipses.

2) The student will be able to predict the positions of the sun, moon, and Earth in solar and lunar eclipses.

The learner outcomes for these objectives will be for the student to explain how lunar and solar eclipses happen. They will also be able to create a model which correctly positions the Earth, moon, and sun during lunar and solar eclipses.

Why Does the Moon Change? (Moons and Moon Phases) (Stacks under construction):

1) Given the appropriate pictures, the learner will formulate a model to explain why we see moon phases.

2) Given a moon observation data table, the learner will interpret the data and use them to predict the moon phases from the observed sequence.

The learner outcomes being targeted in this section are for the students to formulate a model that demonstrates the relative positions and motions of the sun, Earth, and moon that cause moon phases.

How are Earth and the Moon Different? (Gravity)

1) Given the appropriate demonstration of graphic apples falling onto the ground, the learner will conclude what

gravity is like on Earth.

2) After viewing two movies on gravity in space and on the moon , the learner will conclude that the gravity on Earth is much stronger than the gravity on the moon or in space.

The learning outcomes of this activity include being able to contrast the gravity of Earth with that of the moon.

Are There Reasons for the Seasons? (Seasons) (Stack under construction)

1) Given the appropriate pictures, the learner will formulate a model of how the sun's rays strike Earth's surface at different times of the year.

2) Given the appropriate pictures, the learner will predict and measure the size of the area covered by equal light energy striking Earth from different angles.

3) Upon completion of the two activities, the learner will infer that a location's position relative to the sun's direct rays will help decide the location's season.

4) Given the appropriate pictures, the learner will understand that Earth's tilt will affect how many hours of light and darkness a given place will have.

The learning outcomes of this section include formulating a model of how the sun rays will strike Earth's surface differently at different times of the year, measuring the different amount of area covered by equal amounts of light energy striking Earth at different angles, inferring that the angle of the sun's rays is responsible for

temperature differences during seasons, and measuring the relative number of daylight hours in winter and in summer.

Appendix F: Astronomy Unit Curriculum Questionnaire

Present teaching assignment (Subject/Grade Level): _____

Number of years teaching this subject: _____

1. What I liked best about this curriculum: _____

2. What I liked least about this curriculum: _____

3. Suggestions on how the curriculum could be improved: _____

Appendix G: Software Questionnaire

Space Encounter Software Review

Age: _____

Grade: _____

Gender: Male Female

Primary Language: English Spanish Vietnamese

Other: _____

Please write your answers or circle the appropriate response to the following questions.

1. What did you like most about the program?

2. What did you like least about the program?

3. What problems did you have, if any?

4. Was the program easy to follow? Yes No

Explain: _____

5. Did you like the pictures? Yes No

6. Did you like the movies? Yes No

7. Did you like the drawings? Yes No

8. Were the directions easy to follow? Yes No

9. How was the reading level ? too hard too easy just right

10. How was the length of reading? too long too short

11. How was the reading? interesting boring just right informative

12. Did you have the computer read the text to you? Yes No

13. If yes to #12, did you like hearing the words read to you?
Yes No

14. If yes to #12, did you like the speed of the computer voice?
Yes No

15. Did you learn anything? Yes No

16. If yes to #15, what did you learn?

14. Did you enjoy viewing the program? Yes No

15. Was looking at the software more fun than reading from a book about the Earth, moon, and sun? Yes No

Additional Comments:

Thank you for participating in this survey. I appreciate your input.

Mrs. Bower

Appendix H: Consent Form
Consent Form

I, _____, agree to participate in the research entitled "Space Encounter" which is being conducted by Pat Bower of East Heritage Elementary School (Tel. 909-823-5696). I understand that this participation is entirely voluntary; I can withdraw my consent at anytime without penalty and have the results of the participation, to the extent that it can be identified as mine, returned to me, removed from the experimental records, or destroyed.

The following have been explained to me:

1. The reason for the research is to determine if the use of a multimedia software program enhances the learning of scientific information about the relationship of the Earth, moon and sun. There is also information about the solar system included in the software. The benefit I may expect from using the software is to learn more about these relationships and the solar system.

2. The procedure I will be involved in includes viewing the software program written by Mrs. Bower and answering a survey. This will take approximately thirty minutes.

3. This participation will not in any way affect how I am evaluated in my regular class and will involve no risks of any kind.

4. The results of this participation will remain confidential, and will not be released in any individually identifiable form without my prior consent, unless required by law. The only personal information I need to supply the investigator are age, gender, grade level, and primary language. Any other information will be given on a voluntary basis.

5. There are no foreseeable risks involved with this study. The benefits the participant can expect to receive are: (1) new knowledge about the relationship of the Earth, moon, and sun and (2) a preview of some new capabilities of HyperStudio multimedia software.

6. The investigator will answer any further questions about the study either now or during the course of the investigation. Please contact the investigator regarding questions about the participant's rights or injuries.

7. This research has been approved by the Institutional Review Board.

Signature of Participant

Signature of Investigator

Signature of Participant's Parent

Date: _____

PLEASE SIGN BOTH COPIES OF THIS FORM. KEEP ONE AND RETURN
THE OTHER TO THE INVESTIGATOR.

Appendix I: Student Feedback Received

The results of the student feedback are as follows:

Question 1: What did you like most about the program?

Responses: solar system, solar eclipse, really neat movies, rotation, working the moon gravity, that it had a lot of pictures and it was colorful, the graphics the most, the pictures, the movies (2), and the sound that they make.

Question 2: What did you like least about the program?

Response: gravity, the Thinking Journal (2), the movies went too slow, gravity, a game I could not play, when the apples fall down, the reading level was too easy, the voice (2), gravity and the ones that said, "This Stack is Under Construction".

Question 3: What problems did you have, if any?

Response: No problems (8), Mars did not work at all (2), the movie got stuck.

Question 4: Was the program easy to follow?

Response: Yes (11), No (0), the directions were easy, because all you had to do was to click on the buttons, all you had to do was push buttons, there were directions, it was pretty easy, there was nothing hard, very organized, easy, the reading was so outstanding.

Question 5: Did you like the pictures?

Response: Yes (11) No (0)

Question 6: Did you like the movies?

Response: Yes (11) No (0)

Question 7: Did you like the drawings?

Response: Yes (11) No (0)

Question 8: Were the directions easy to follow?

Response: Yes (11) No (0)

Question 9: How was the reading level?

Response: too hard (0), too easy (2), just right (9)

Question 10: How was the length of the reading?

Response: too long(1), too short(0), just right(10)

Question 11: How was the reading?

Response: interesting(10), boring(0), informative(1)

Question 12: Did you have the computer read the text to you?

Response: yes (11), no(0)

Question 13: If yes to #12, did you like hearing the words read to you?

Response: yes(11), no(0)

Question 14: If yes to #12, did you like the speed of the computer voice?

Response: yes(4), no(7)

Question 15: Did you learn anything?

Response: yes(9), no(2)

Question 16: If yes to #15, what did you learn?

Response:

- Solar eclipses happen every so often. If your Earth weight is 60, divide it by 6 and that is your moon weight.
- That the moon goes around the Earth.
- That it takes Pluto over 90,000 Earth days to go around the sun.

- I learned nothing because I already learned it on my computer.
- That the Earth has to be lined up with the moon to have a solar eclipse happen.
- I learned that satellites rotate too.
- I learned that I don't want to be a spaceman.
- I learned a lot.
- I learned about the solar system and that people named Venus after the goddess of love and beauty.

Question 14: Did you enjoy viewing the program?

Response: yes(11), no(0)

Question 15: Was looking at the software more fun than reading from a book about the Earth, moon, and sun?

Response: yes(11), no(0)

Additional Comments:

Responses:

- I think it was very educational. I loved the program. If it is not on every computer, it should be. This should be a science unit in our curriculum.
- I didn't like that I didn't get to use the internet.
- I think that the program was fun. It was very very neat.
- I liked it and enjoyed it.
- I liked the movies and I didn't like the games they didn't let us play with. My favorite movie was when the satellites rotate.

- I want to know how many stars are in the sky.

The results of the two teachers' feedback were interesting as well. The author appreciates their willingness to participate in the activity. Each teacher gave open and honest comments to the questions asked. The results of their responses are as follows:

Question 1: What did you like most about the program?

Responses: the movies, it was very informative, useful to our science curriculum

Question 2: What did you like least about the program?

Response: nothing (2)

Question 3: What problems did you have, if any?

Response: No problems (2)

Question 4: Was the program easy to follow?

Response: Yes (2), No (0)

Question 5: Did you like the pictures?

Response: Yes (2) No (0)

Question 6: Did you like the movies?

Response: Yes (2) No (0)

Question 7: Did you like the drawings?

Response: Yes (2) No (0)

Question 8: Were the directions easy to follow?

Response: Yes (2) No (0)

Question 9: How was the reading level?

Response: too hard (0), too easy (0), just right (2)

Question 10: How was the length of the reading?

Response: too long(0), too short(0), just right(2)

Question 11: How was the reading?

Response: interesting(0), boring(0), informative(2)

Question 12: Did you have the computer read the text to you?

Response: yes (1), no(1)

Question 13: If yes to #12, did you like hearing the words read to you?

Response: yes(1), no(0)

Question 14: If yes to #12, did you like the speed of the computer voice?

Response: yes(1), no(0)

Question 15: Did you learn anything?

Response: yes(2), no(0)

Question 16: If yes to #15, what did you learn?

Response:

- how satellites rotate
- how fast a person at the equator travels per hour

Question 14: Did you enjoy viewing the program?

Response: yes(2), no(0)

Question 15: Was looking at the software more fun than reading from a book about the Earth, moon, and sun?

Response: yes(2), no(0)

Additional Comments:

Responses:

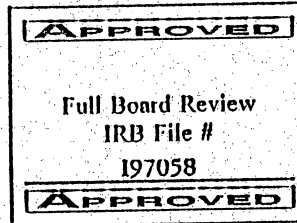
- The sounds were great. It was very easy to use and follow. The film strip movies were great! I loved the interesting fact on the rotation part - the mouse flying by at 1,036 mph. I also loved the asteroid belt movie.

- I like how the text was written to click on a video. This way I didn't miss anything.

Appendix J: IRB Permission



CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO



The California
State University

April 18, 1997

Patricia Bower
c/o Department of Science, Mathematics, and Technology Education
California State University
5500 University Parkway
San Bernardino, California 92407

Dear Ms. Bower:

Your application to use human subjects in research, titled, "Effective Use of Multimedia in the Classroom: Enhancing Third Grade Science Curriculum," has been reviewed by the Institutional Review Board (IRB). Your application has been approved. Please notify the IRB if any substantive changes are made in your research prospectus and/or any unanticipated risks to subjects arise.

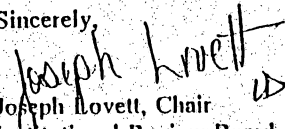
Your informed consent statement should contain a statement that reads, "This research has been reviewed and approved by the Institutional Review Board of California State University, San Bernardino."

If your project lasts longer than one year, you must reapply for approval at the end of each year. You are required to keep copies of the informed consent forms and data for at least three years.

If you have any questions regarding the IRB decision, please contact Lynn Douglass, IRB Secretary. Ms. Douglass can be reached by phone at (909) 880-5027, by fax at (909) 880-7028, or by email at ldouglas@wiley.csusb.edu. Please include your application identification number (above) in all correspondence.

Best of luck with your research.

Sincerely,

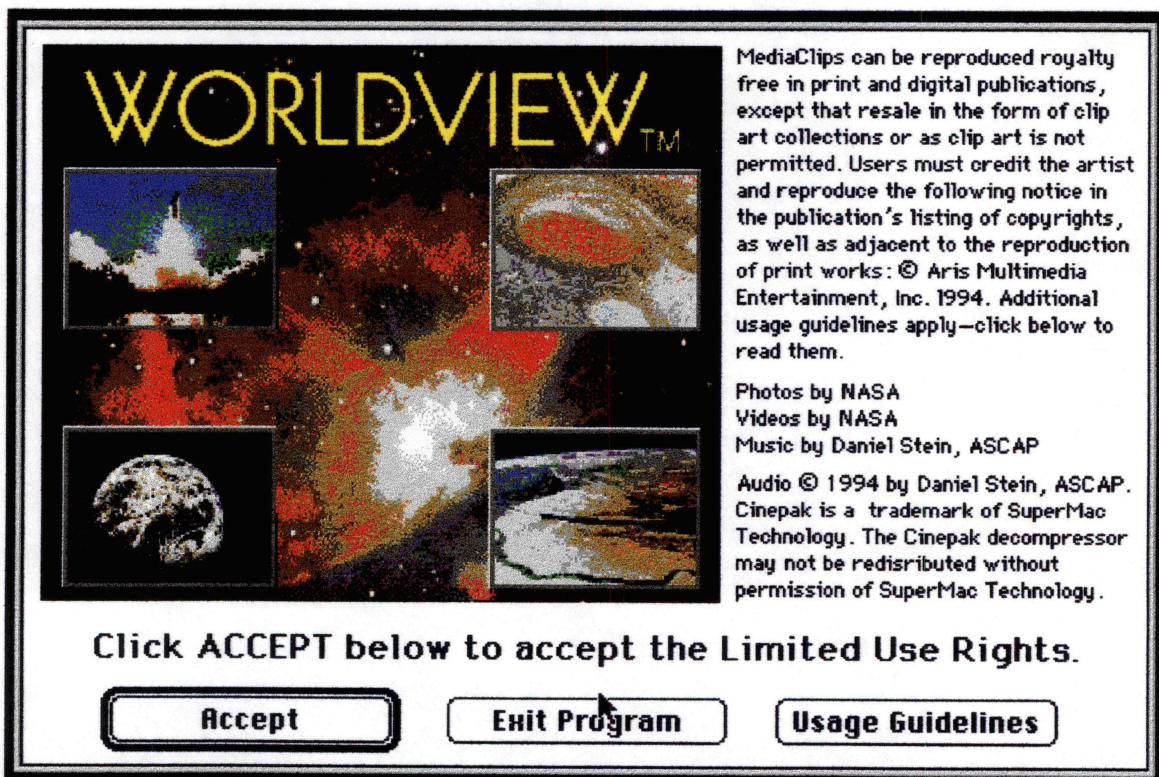

Joseph Lovett, Chair
Institutional Review Board

JL/ld

cc: Rowena Santiago, Science, Mathematics, and Technology Education

Appendix K: Copyrighted References

1) The pictures, music and video included in the Space Encounter software are copyright-free materials from World View [CD-ROM], Photos and Video: NASA, Music: Brehm J., & Mannis K., 1991-3, Marina del Rey, CA: Aris Multimedia Entertainment Inc. Copyrighted by Aris Multimedia Entertainment Inc. Copyright permission reproduced below.



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