The Development and Evaluation of a Music Mnemonic-Enhanced Multimedia Computer-Aided Science Instructional Module

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(ABSTRACT)

"CellSong" is a computer aided instructional (CAI) science module designed to help students recall information about cellular physiology. The program is designed to teach middle school learners the music mnemonic "Cell's Organelles" (©1995 Karl Kimmel) in order to facilitate the recall of the targeted biological information. In addition to music, a computer animation is synched to the five minute music file to provide visual reinforcement for the song's lyrics.

Two male teachers, from two different rural southern schools (mTeacher and sTeacher) implemented the "CellSong" module in their classes. Students in mTeacher's class consisted of 12 fifth grade biology students. The other group was initially composed of all of sTeacher's sixth grade science classes (n=38). This group was divided into the regular three classes on its second exposure to the program.

The students filled out attitude surveys after five exposures to the program. All the sixth grade students took an aided recall tests immediately after the fifth exposure to the program. Thirteen of the sixth graders took the same test (retest) after seven days. Although the test scores were generally low, students who took the retest tended to be able recall the same items that they had recalled the week before.

The fifth grade class took one recall test four days after their last exposure to the program and scored higher than the sixth grade from the other school. These students were more favorable in their responses on the attitudinal survey. Students in the fifth grade class (and female students in the sixth grade classes) tended to enjoy the module and music mnemonic strategy. The sixth grade boys reported not enjoying it.

Dedication

This paper is dedicated to the memory of my father

Allan Lee Kimmel

(1926 - 1998)

a committed educator, lifelong student, gifted musician,

loving husband, extraordinary father

and all I have ever aspired to be.

Thank you for all your help, support and love.

I wish he was here to see it finished.

He is missed.

Acknowledgments

I would like to express my appreciation and thanks to the co-chairs, Drs. Glen Holmes and Greg Sherman, and to the members of my committee Drs. Vernon Burnsed, John Burton, Sue Magliaro, Michael Moore, for their council, encouragement, constructive criticism and support throughout the doctoral program.

A special acknowledgment is due Glen Holmes for his patience and invaluable suggestions through each step of my graduate education and to Greg Sherman for his tremendous help and guidance in the creation, design and editing of this document.

I thank my daughter Tiffany Kimmel for the hours she spent helping to create the artwork used in the animation. I am grateful to Tina Kimmel, for singing the song on the recording and contributing some of the most effective and imaginative animation ideas used in the program. I would like to express my gratitude to Courtland Stewart's for his assistance in engineering the audio recording.

I would like to express my appreciation to the master teachers, Steve Halterman, Carolyn Holdren and Dave Peters, for their time and valuable insights. Without their help and the cooperation the many administrators, parents and students contacted though out the research process, this study would not have been possible.

Additionally, I would like to thank Francine Solomon for being there and helping out when everything seemed the bleakest. I express my deep appreciation to my loving Aunt Sondra Jordan, who helped glue me back together whenever my world fell apart. I am grateful to my younger daughter Kathryn, who for five of her seven years, has had a working father in graduate school and nevertheless continues to love him. I am grateful to my former house-mates Ron Free, David Morrison, Debra Wagner and Arthur Wangler for their help, patience and assistance with Kathryn. I thank Kay Kimmel for remaining a constant support and friend. I express my deep appreciation to Ashley Smith for her consistent willingness to help.

I thank Jon West, my partner, trusted friend and excellent musician, for protecting our company and more specifically my job whenever my academic and musical careers collided. I also thank Frank Spicer for being willing to sub for me on such short notice.

I am deeply grateful to my mother, Margaret Kimmel, and all my family and friends for their tireless support and encouragement throughout my masters and doctoral programs.

Finally, I wish to express my love and heartfelt appreciation to my incredibly helpful wife, Teresa Kimmel, who has generously brought beauty, unfailing support, fun, tenderness and our son, Kyle into my life.

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Chapter 1. Introduction

"CellSong" is an interactive multimedia, computer-assisted instructional (CAI) program that provides a highly elaborative rehearsal vehicle to aid middle-school life science students in the recall of specific biological concepts and facts. It functions to help a group of students learn a song about cellular physiology. In the song "Cell's Organelles" (Kimmel, 1998), the text of a series of lessons about cellular physiology is reconstructed into the lyric of a song. The resulting music mnemonic is coupled with an animation that uses visual metaphors to illustrate concepts relating to the lyric and thereby reinforce them. Additionally, a metaphor structured into the song and program highlights the similarity between the simultaneity and individuality of the functions of the musical instruments working within a musical system and the simultaneity and individuality of the functions of the cell's organelles and processes occurring in the living cell's biological system.

This report summarizes the development and evaluation of the "CellSong" instructional program. It documents how the development of the program incorporated the findings of contemporary empirical research concerned with musical and lyrical facilitation of recall, as well as research dealing with the implementation and development of other types of mnemonic teaching strategies. The song, "Cells Organelles," was written to explain, as thoroughly and aesthetically as possible, the targeted verbal information. Clarifications of these compositional considerations used in crafting the song are conveyed. The report relates how specific graphics and animations were created in order to make the lyrical content more tangible to the targeted students. The design of the "CellSong" computer application, which combines the song and animation with an intuitive user interface, is described. The expert review and one-to-one (with subject sophisticates) evaluational procedures are summarized, as are resultant changes made to the program's user interface. Finally, data from the small groups and field test evaluational procedures are summarized and discussed.

Wallace (1994) concluded that a song can aid recall if the melody is repetitive and easy to learn, the lyrics and melody agree rhythmically, the reconstruction of targeted

content into a lyric makes good use of rhyme, imagery and poetics, is understandable, and the lyric is rehearsed or presented several times. It is therefore expected that when students learn the song employed as a music mnemonic in "CellSong," their ability to recall the biological information contained within it will be facilitated. These concepts and facts are made more concrete to the students through the utilization of cartoon-like two-dimensional animation. Musical instruction is provided so that the musical aspects of the song may be studied and attention drawn to the similarities between the musical and cellular systems. This offers learners something familiar with which to associate and understand the new material.

When facing new fields of knowledge, learners are faced with many new classifications, sequences and facts. The terms "fields of knowledge" or "disciplines" refer to knowledge systems. For example, foreign languages, branches of science, history, math, religion, art, etc., have their own jargon or vernacular. Verbal information and concepts only have meaning within the systems as a whole. A comprehension of the whole is a precursor for efficient understanding individual words or concepts. Mastery is difficult because there are too many new things to learn. For example, to effectively learn how to change a tire, subjects should have a working knowledge of the component parts and tools (e.g., the tire, lug nut, jack, car, etc.), know the sequences of the necessary actions (e.g., loosening lug nuts, jacking up car, removing tire, etc.) and an idea of the final goal or purpose of the repair (e.g., car's functionality is enhanced when tires are filled with air). If learners have little or inaccurate prior knowledge with which to relate this new knowledge, their ability to accurately recall the mechanical information is inhibited.

Bartlett's (1932) research demonstrated that when subjects are asked to remember new information, they actively relate it to their general world knowledge (or schemata) that pertain to the new information. If the new information does not fit into their world knowledge, they tend to reconstruct the information to make it fit. Researchers suggest a general world knowledge or schema, similar to Bartlett's schema for meaning, also exist for a song's musical structure (Chang & Trehub, 1977; Dowling, 1973; Dowling, 1982; Deutsch, 1977; Gardner, Davidson, & McKernon,1981; Gfeller, 1982; Kessen, Levine, &

Wendrich, 1979; McKernon, 1979, Wallace 1994, Wallace & Rubin 1988, Zenatti, 1975) and lyrical structure (Kelly & Rubin 1988, Rubin 1977 Wallace & Rubin 1988, Wallace 1994). When textual information is presented as the lyric of a song, it is better recalled (Chazin & Neuschatz, 1990; Gfeller, 1982; Wallace, 1994; Yalch, 1991), and its memory is more durable (Wallace, 1994, Experiments 1, 2, and 4).

Gfeller (1982; 1983) demonstrated that the interaction of both repeated musical rehearsal of a music mnemonic and the teacher-directed modeling and cueing of the mnemonic strategy significantly aided retention for both LD and "normal" male children aged 9.0- 11.9. Gfeller also noted that if the musical rehearsal was not modeled, then recall was not significantly facilitated. It has been demonstrated, when using other mnemonic strategies with younger students, that more external support or effort to teach students how to use the strategy is needed for effective recall facilitation. (Pressley & Dennis-Rounds, 1980; McGivern as cited by Pressley, Levin, & Delaney, 1982, p. 66-67; Pressley & Levin, 1978; Pressley, Samuel, Hershey, Bishop, & Dickinson, 1980; Miller, Levin, & Pressley, 1980; as cited by Pressley, Levin & Delaney, 1982, p. 71-72)

The successes of mnemonic strategies utilizing imagery to enhance recall (i.e., Keyword mnemonics) have been widely demonstrated. Although the mnemonic itself is semantically unrelated to the targeted knowledge, information stored using imagery is well remembered. The "Reconstructive Elaboration Model" described by Scruggs and Mastropieri (1990, p. 275) employs pictures of keyword mnemonics or acoustical reconstructions for encoding unfamiliar information (see Figure 1.), symbolic pictures (symbolic reconstruction - i. e., scales to represent justice), and literal pictures (mimetic reconstructions) are used for familiar, concrete information. This model is used to adapt entire domains of content to mnemonic instruction. Other types of mnemonics may also be used when appropriate. The idea behind this model is that the more concrete a subject can be made to a learner, the better it will be remembered.

The CellSong program is based on the "Reconstructive Elaboration Model" but with some differences. The program utilizes animation instead of static pictures in order to make whole concepts concrete. To make the verbal information more memorable,

CellSong uses a music mnemonic rather than text. This song attempts to make all the related concepts and verbal information a cohesive whole and therefore more understandable and memorable.

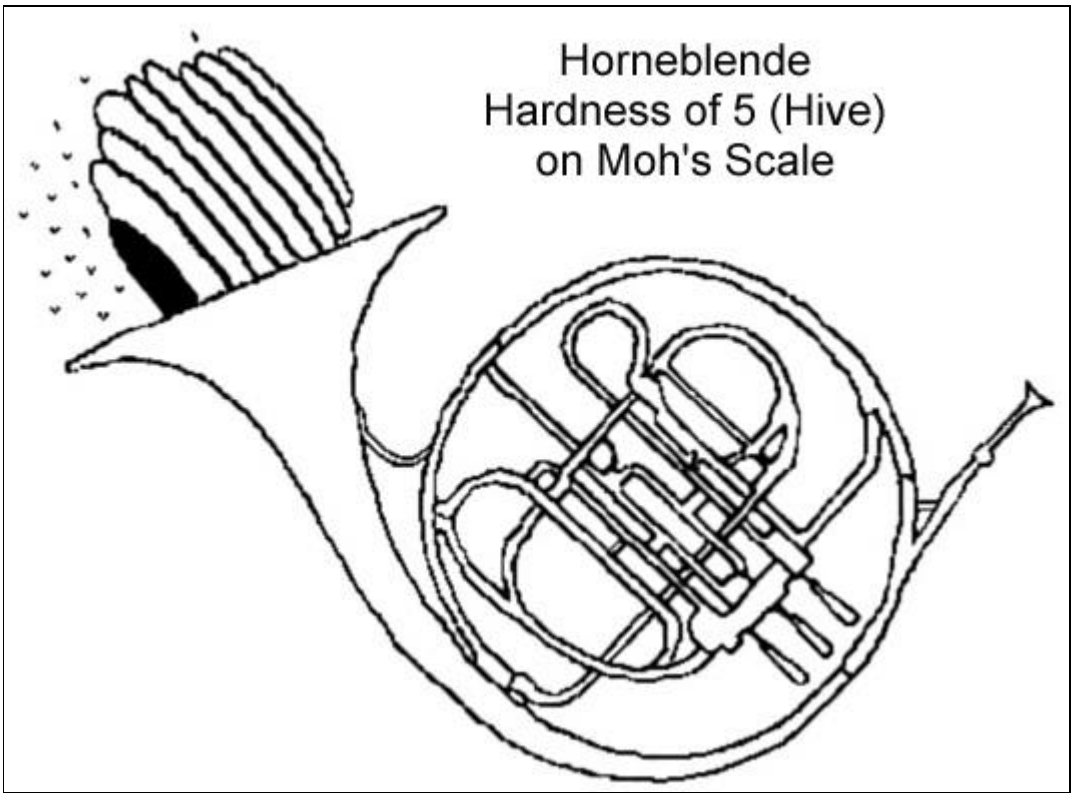


Figure 1 - Keyword Mnemonic
This example of the "Reconstructive Elaboration Model" uses a picture of a horn (the keyword mnemonic) and a beehive (from the pegword mnemonic, "five is a hive") to lock in the knowledge that "hornblende" is a mineral with a hardness of five on Moh's scale.

Description of the "CellSong" Program

"CellSong" was designed for groups of English-speaking, middle school, life science students of any ethnicity or gender. The program's function was to facilitate the students' recall of the concepts and facts necessary for mastery of a cellular physiology unit. The program runs slightly over five minutes in length. The field tests were conducted

using whole classes and were directed by the students' science teachers (mTeacher, sTeacher). Students had some previous instruction in cellular physiology.

Program Components.

The **"**CellSong" instructional program is comprised of a computer program that supplies graphic animation and dynamically controls the digital musical file for the song. "CellSong.exe" (K. Kimmel, T. J. Kimmel, T. R. Kimmel & C. Stewart, 1998) is designed to help students learn the song "Cell's Organelles." It was meant to be operated by a middle-school life science teacher to instruct a whole class using a large monitor or LCD overhead projector. The program can also be operated by individual students in centers using headphones. Animations are integrated with the song's lyrics to illustrate various organelles and cellular functions. In presenting the song to the class, it was recommended that the instructors should model the singing behavior. It could also be made available for students on individual work stations. In order to ensure recall facilitation, students were to sing the biological portion of the song a minimum five times.

Technical specifications of the program are summarized in Appendix A. The recording procedures used to record the "Cell's Organelles" song are summarized in Appendix B. Software models used in developing the program are discussed in Appendix C.

Program Objectives.

As previously described, "CellSong" was designed in accordance with empirical evidence regarding the use of a music mnemonic. It was anticipated that students would improve their recall of the targeted information presented within the song. Visual examples and metaphors were used to make the information contained in the mnemonic more concrete. Accordingly, an aided recall test was employed to determine whether students were able to recall the targeted knowledge. In order to determine how much of the targeted knowledge was stored in long-term memory, an aided recall test was given

about a week after students sang the song for the last time. (See Appendix D for Aided Recall Test.)

It was hoped that "CellSong" would facilitate broad-based learning in mainstreamed, diversified middle-school life-science classrooms. It was expected that programs of this type would be useful in the same instructional situations that image-based mnemonics have proven successful (e.g., with populations that generally have difficulty remembering or in educational disciplines where memorization of foundational knowledge is necessary for academic success).

"Cell's Organelles" (Kimmel, 1995) is a song composed to help middle-school students recall aspects of cell structure and their organelles. It was written in accordance with the Life Science Standards of Learning (SOL) for Virginia Public Schools (State Board of Education, 1995). The specific key concepts covered by the song include:

LS. 2 - Cell structure and organelles

> Cell membrane, cell wall, vacuole, mitochondrion, endoplasmic reticulum, nucleus and chloroplast); Similarities and differences between plant and animal cells;

LS.3 - cellular transport (specifically diffusion and active transport);

LS.6 - energy transfer between sunlight and chlorophyll. (p. 45)

Cells structures and organelles covered by the program are introduced in the first verse of the song as a group, "Specialized functions in living cells are performed by bodies known as organelles." The organelles are successively displayed on the screen (see Figure 4). The chorus of the song also deals with the organelles as a group. Lyrically it states "Organelles work in cells. Specialties in harmony." The program displays the organelles going to work in a cell. Then an image of the organelles performing their individual cellular function is presented. The animation cuts to an image of each organelle playing a musical instrument (see Figure 5). This animation sequence was used to highlight the simultaneity and individuality of the organelles' functions within the biological system of the cell. The visualization of this metaphor between a biological and a musical system is

also used to address two national musical SOL's: SOL 8 "Understanding Relationships between music …and disciplines outside the arts," and SOL 8b "The students will apply information learned in music to science classes." (National Association for Music Education, 1998).

The concept of components functioning simultaneously in order to maintain a system occurs both in musical compositions (the instruments and voices) and a cell (the organelles). The roles of the various musical instruments within the song function are presented at the beginning of the song ("Notated mode") so that the simultaneity of their function may be discussed and compared.

This concept of simultaneity of component function is also presented musically within the song. After several organelles or cellular functions are introduced, the vocals are layered into counterpoint. A melody must be learned in order to facilitate the recall of its lyric (Wallace 1994, experiments 3 and 4). As students are not be able to sing the different parts until they master the melody, this counterpoint furnishes the teacher with an intrinsic gauge for determining students' mastery of the melody.

The lyrics of the "Cell's Organelles" song state "In every cell what goes in or out, needs a cell membrane to figure it out," which addresses the life science SOL dealing with cell membranes. Visually, the program presents an animation that flashes both the animal and plant cell's membranes while arrows move into and out of the cell (see Figure 6). The animation then drops away all the cell parts except the outlines of the cell membranes. These outlines then morph into question marks (see Figure 7). It was presumed that students would try to figure out what the membrane was morphing into, thus providing a metaphor for the function of the cell membrane.

The song addresses the function of the plant's cell wall by stating "Cellulose in the plant cell wall keeps a plant rigid so plants can grow tall." The animation flashes the cell wall to show its location within the cell. The fact that animal cells do not have cell walls was not specifically addressed by the program (see Figure 8, Frames 1 and 2). Next, the animation displays a series of frames to demonstrate a growing plant. Rigidity is suggested by successively building new portions of the plant on top of the younger sections (see

Figure 8, Frames 3-7).

The cellular function of vacuoles are addressed in the song stanza “Vacuoles are bubble-like structures, Used for storing wastes and extra food and water.” Visually, the program presents bubbles rising around and between the pictured animal and plant cell while the vacuoles are flashed. Although visually apparent, the difference in the shape and size of the animal cell’s vacuoles and the plant cell’s vacuoles is not spoken to in the song’s lyric (see Figure 9, Note: The arrows were not present in the actual animation). The animation then presents a garbage pail, a dinner plate and a cup of water as metaphors for cellular wastes, food and water.

The song uses alliteration and assonance to poetically connect the concept of the function of the mitochondrion and its “powerhouse” function, stating “In the cells of animals, plants like flowers, the mighty mitochondria provide the power.” Visually, while all of the cells’ mitochondria are flashing, two mitochondria are brought out of the cell and morphed into an arm flexing the biceps muscle (see Figure 10, Frames 2 - 5). The lyric further defines the mitochondria’s biochemical function, adding “Packaging sugar’s energy, Into practical portions of ATP.” The animation presents a spoon coming out of a sugar bowl. As a metaphor for sugar’s exothermic chemical nature, the sugar in both the spoon and bowl appear to explode (see Figure 11, Frames 1 and 2). The animation then provides a visual metaphor for the biochemical process, oxidative phosphorylation, by cutting to a mitochondrion figure spooning smaller portions of this energy into packets labeled ATP (see Figure 11, Frames 3-6).

Although there is no mention of ribosomes in Virginia’s middle school SOL’s at this grade level, the program’s designer felt that a discussion of the cellular function of the nucleus and endoplasmic reticulum would be incomplete without including them. Additionally, ribosomes were discussed in all the middle school life science textbooks reviewed by the designer. The function of ribosomes is presented lyrically, “The ribosome is where the protein’s made, Following directions from the DNA.” The animation flashes the ribosomes to indicate their location and relative size within the cell. At the same time, two of the ribosomes are enlarged and brought to the center of the screen (see Figure 12,

Frames 1 - 6). The enlarged ribosomes are then shown stringing together balls (representing amino acids) while viewing a strand of messenger RNA (see Figure 12, Frames 7 - 9). This animation provides a visual metaphor for the ribosomes role in protein synthesis.

The song's lyric states the function of the endoplasmic reticulum: "The endoplasmic reticulum, Gives the nucleus a network for communication." The animation again flashes the organelle. In the next series of frames, the animal cell's endoplasmic reticulum is enlarged and the plant and animal cells in the background disappear (see Figure 13, Frames 1 - 6). Finally, a nucleus is portrayed speaking to two ribosomes on a phone system where the endoplasmic reticulum is the connecting wire network (see Figure 13, Frame 7).

The program does not go into the nucleus' role in cellular reproduction; consequently, it is limited to covering the nucleus' role in protein synthesis. The song's lyric states "Chromatin in the nucleus, Holds the plans for protein synthesis." Visually, the chromatin in the nucleus is flashed (see Figure 14, Frame 1). The animation then cuts to a depiction of two DNA molecules. This was structured to ensure students could understand that DNA, stored in the nucleus of a cell, holds the plans for protein synthesis. This segment of the program, coupled with the segments dealing with the roles of the endoplasmic reticulum and ribosomes, was developed to help the students form a fairly comprehensive conception about the cellular process of protein production.

The lyric describes the functions of chloroplasts and chlorophyll within a plant cell without delving into biochemistry. It states, "Chloroplasts in a green plant cell, Capture solar energy with Chlorophyll." The display again flashes the organelle. The animation cuts to a chloroplast character, holding a butterfly net, and chasing and capturing a ray of sunlight. The butterfly net was intended to represent the function of the chemical compound chlorophyll (see Figure 15). The program does not directly state that animal cells do not have chloroplasts nor does it discuss the process of discuss photosynthesis.

Diffusion and active transport are covered using a flat tire as a visual metaphor. The lyrics state " Concentrations move from high to low, diffusion won't need energy to

make it flow." Visually, a dense concentration of carbon dioxide molecules is shown in the center of the screen, surrounded by a semi-permeable membrane represented by a dotted line. Arrows move and point to the outside of the membrane, representing the direction of the concentration gradient. Then the animation shows a tire losing air (see Figure 16). Next, to describe active transport, the lyric states, "When concentrations move from low to high, They're actively transported to the higher supply." The same image of the carbon dioxide molecules and semi-permeable membrane is used; however, the arrows move and point in the opposite direction, into the area of higher concentration. The same image of the flat tire is shown with a pump inflating the tire (see Figure 17). It was hoped that students would infer that it requires energy to move molecules across a semi-permeable against a concentration gradient.

Interface.

Eight buttons, located at the top of the screen, allow teachers to manipulate the program (see Figure 2.). The "Loop" button causes the program to repeat musical phrases (usually four measures long). Clicking this button brings up a selection list for zero, one, two, three or an infinite number of loops. (See Figure 2.) A loop count of "1," means that a selection will be repeated twice or looped once. The "Skip Back," "Skip Forward," "Rewind," and "Go To" buttons override a loop selection but will not effect the "Loop" button's counting variable. The "Rewind," "Notation" and Denotation" buttons all re-initialize the "Loop" button's counting variable.

The "Denotation" button (see Figure 2) causes the program to remove the musical notation and display a textual version (see Figure 4). It also toggles with the "Notation" button, re-displaying the musical notation. In the "Denotated Mode," the sections of the song that deal with harmony and rhythm are not available to the user. In the "Notation Mode," the "Rewind" button (see Figures 2) returns to the beginning of the musical aspect of the program (see Figures 3). In the "Denotated Mode," the button returns the user to the beginning of the biological portion of the song (see top of Figure 3).

The “Stop” button (see Figure 2[1]) pauses the animation and song. When clicked it toggles to the “Play” button. The “Play button” may then be clicked to restart the program. The “Stop” button allows teachers to show specific stills pictures within the animation. The “Skip Back” button returns to the beginning of the musical section that was just played. The “Skip Forward” skips to the beginning of the next section.

The "Help" button (see Figure 2) displays text that describes all the known issues associated with using the program. The user interface at the top of the screen allows users to click on a button for a textual description of its the functionality. A button at the bottom of the screen allows users to return to the program.

The “Go to” button (see Figure 2) causes the program to go to a specific part of the song. Clicking the button brings up the selection list. The available selections are “Harmony,” “Rhythm,” “First Verse,” “Second Verse,” “Third Verse” and “Cancel.” In the “Denotated Mode,” the selections that deal with harmony and rhythm are deactivated. Clicking on the selection list allows the user to go to the selected part of the program (see Figure 10 and 16).

After students have learned the “Cell’s Organelle’s” song (by way of the “CellSong” program), it was predicted that they would be better able to recall the biological nomenclature and key concepts contained within it. This facilitation of recall should enable students to better employ this knowledge in more complex cognitive tasks. The song was written using a simple melodic, rhythmic and harmonic structure. There were no interval jumps larger than a major third. The song has a single octave range. The designer made efforts to incorporate some of the National Standards of Learning for music (NAFME, 1998) into the program (see Appendix L). All of music had been notated to encourage reading. The students were encouraged to sing in three part harmony (see Figure 18). The program’s opening “rap” and animation discusses the key signature, time signature, chordal progression. The song was put a half-step below what would be considered the normal vocal range of sixth-grade students in order to encourage beginning students who played a little guitar or electric bass to play along with the program (It is

[1] Note: All figures are located at the end of the chapter in which they are cited

easier to play in the key of “E” than the key of “F” on a guitar or bass). None of the students in either location had difficulty singing the low notes in tune. The designer recognized that if the program were delivered by a music teacher, vocal issues such as singing posture, breathing skills, breath support, enunciation, vocal placement, etc., would be a focus of the lesson.

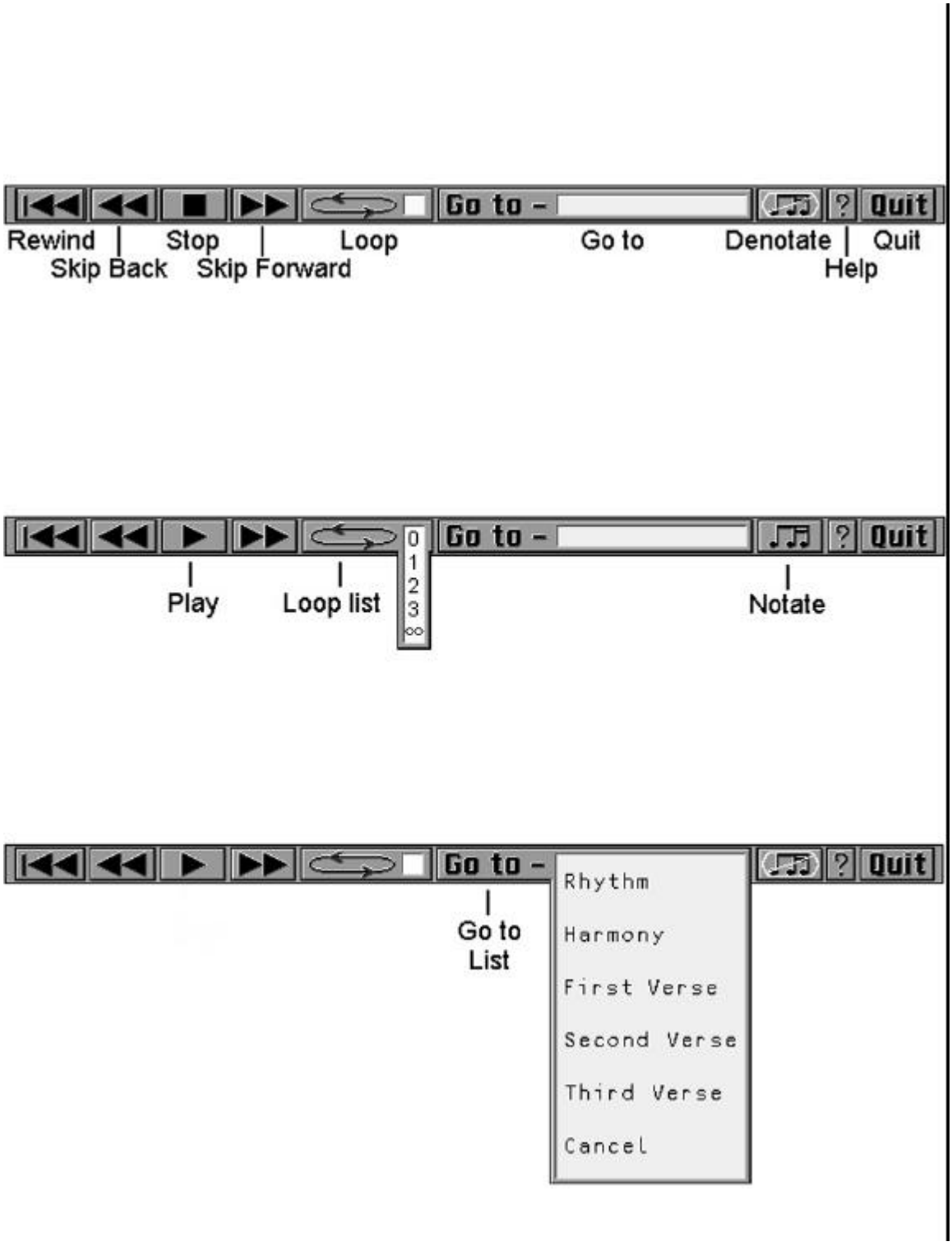


Figure 2 - User Interface

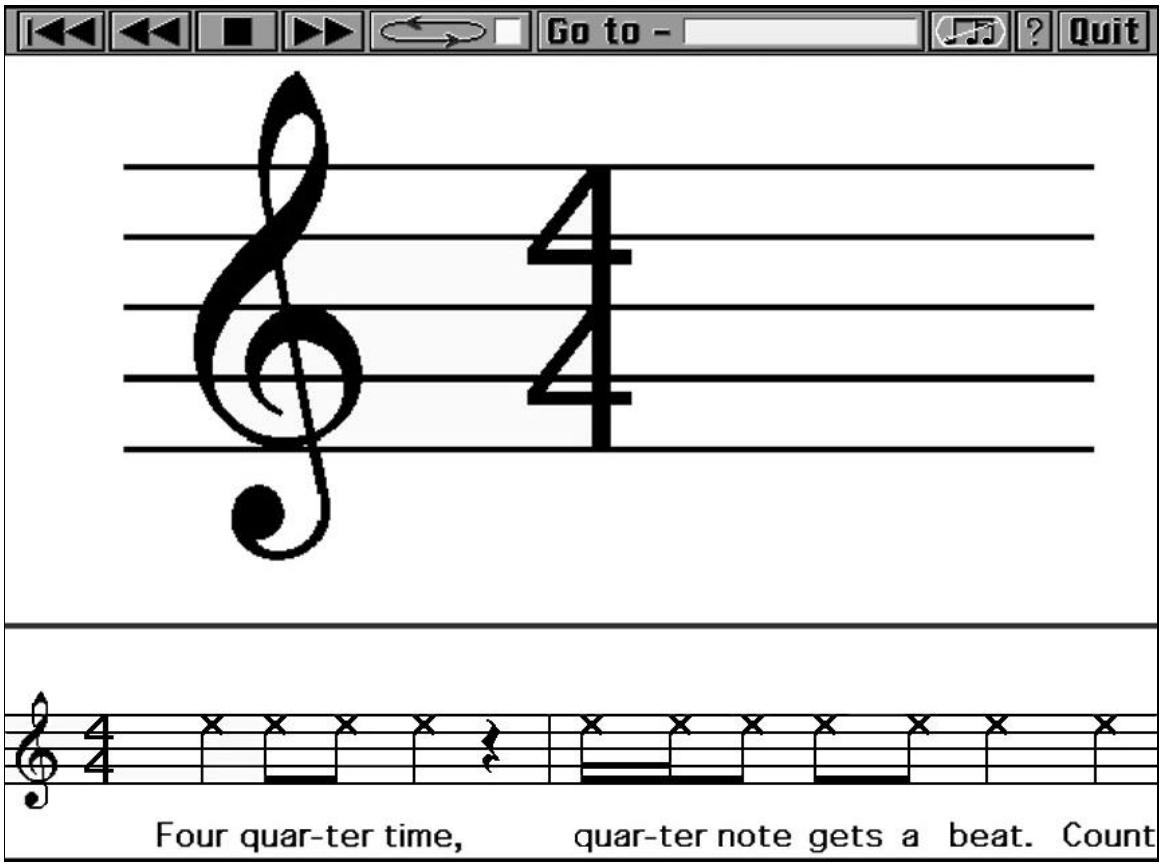


Figure 3 - Time Signature

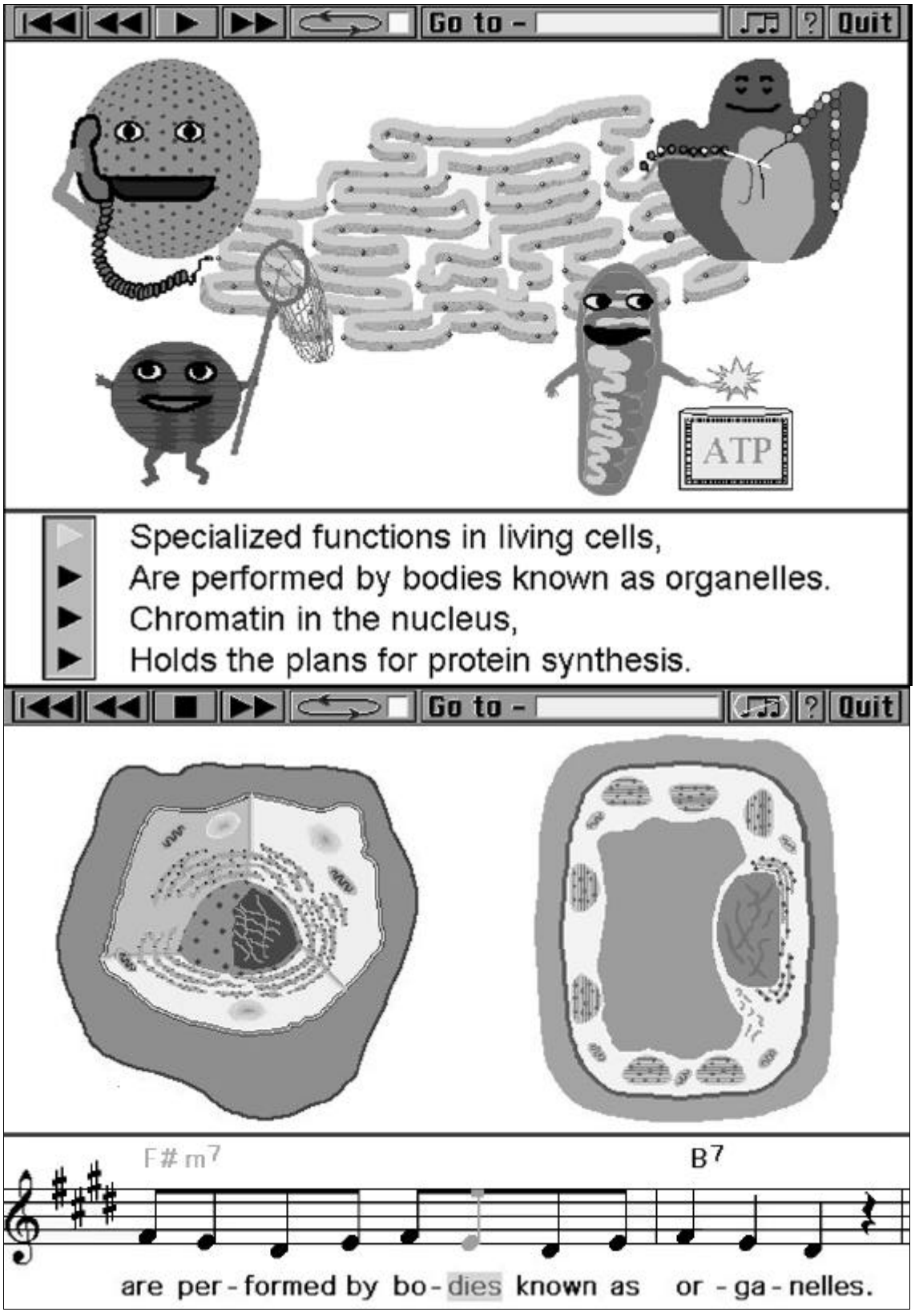


Figure 4 - Organelles I

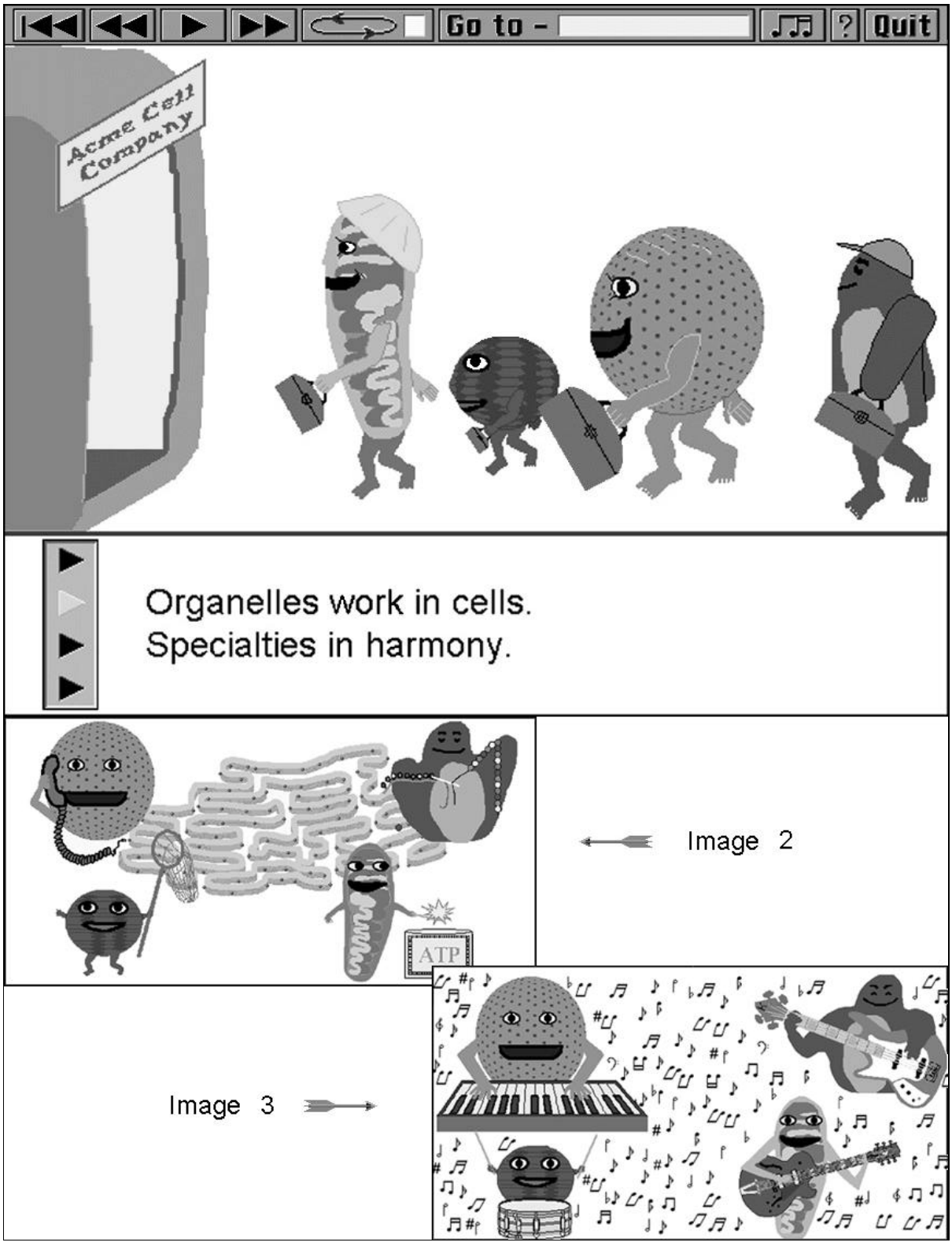


Figure 5 - Organelles II

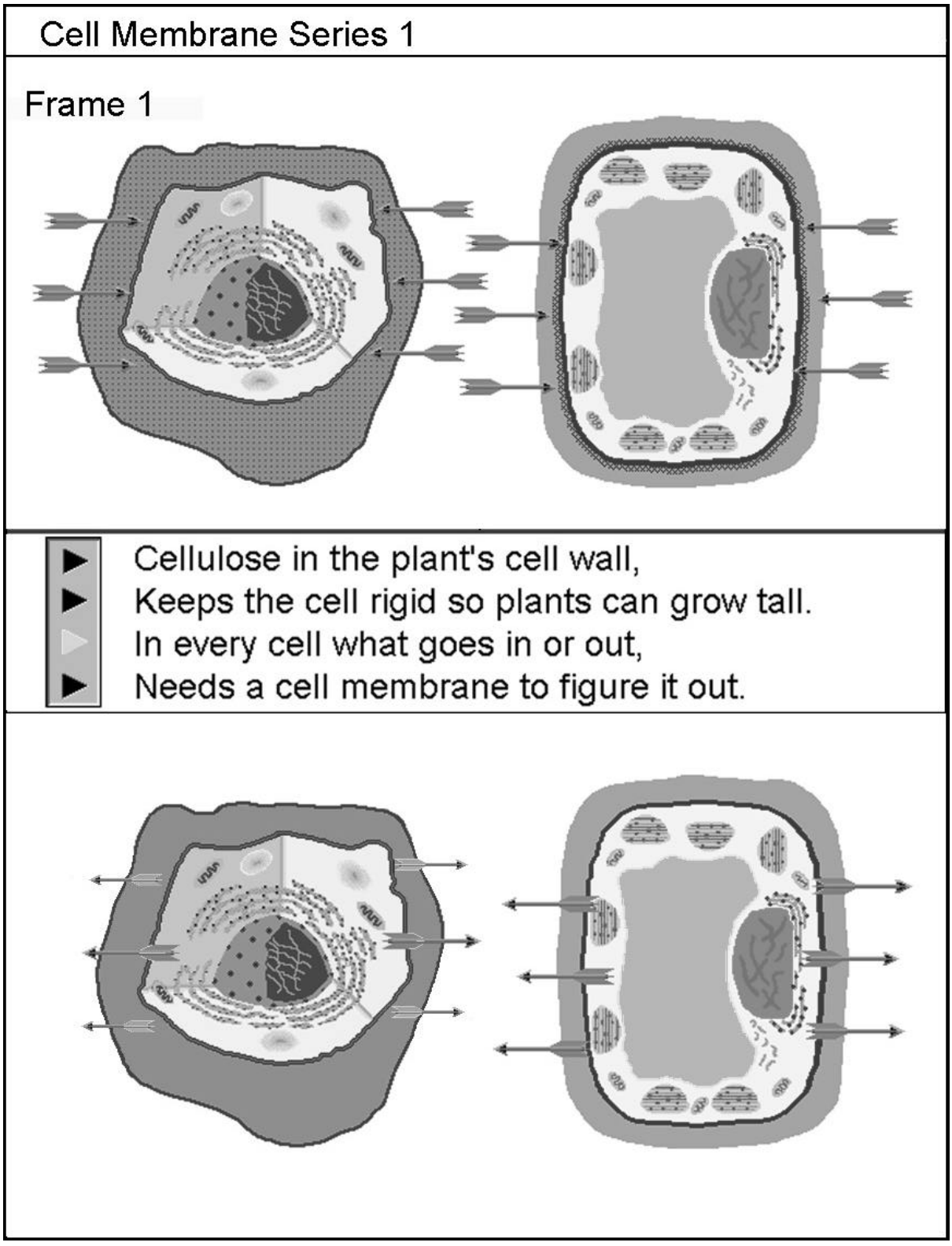


Figure 6 - Cell Membrane I

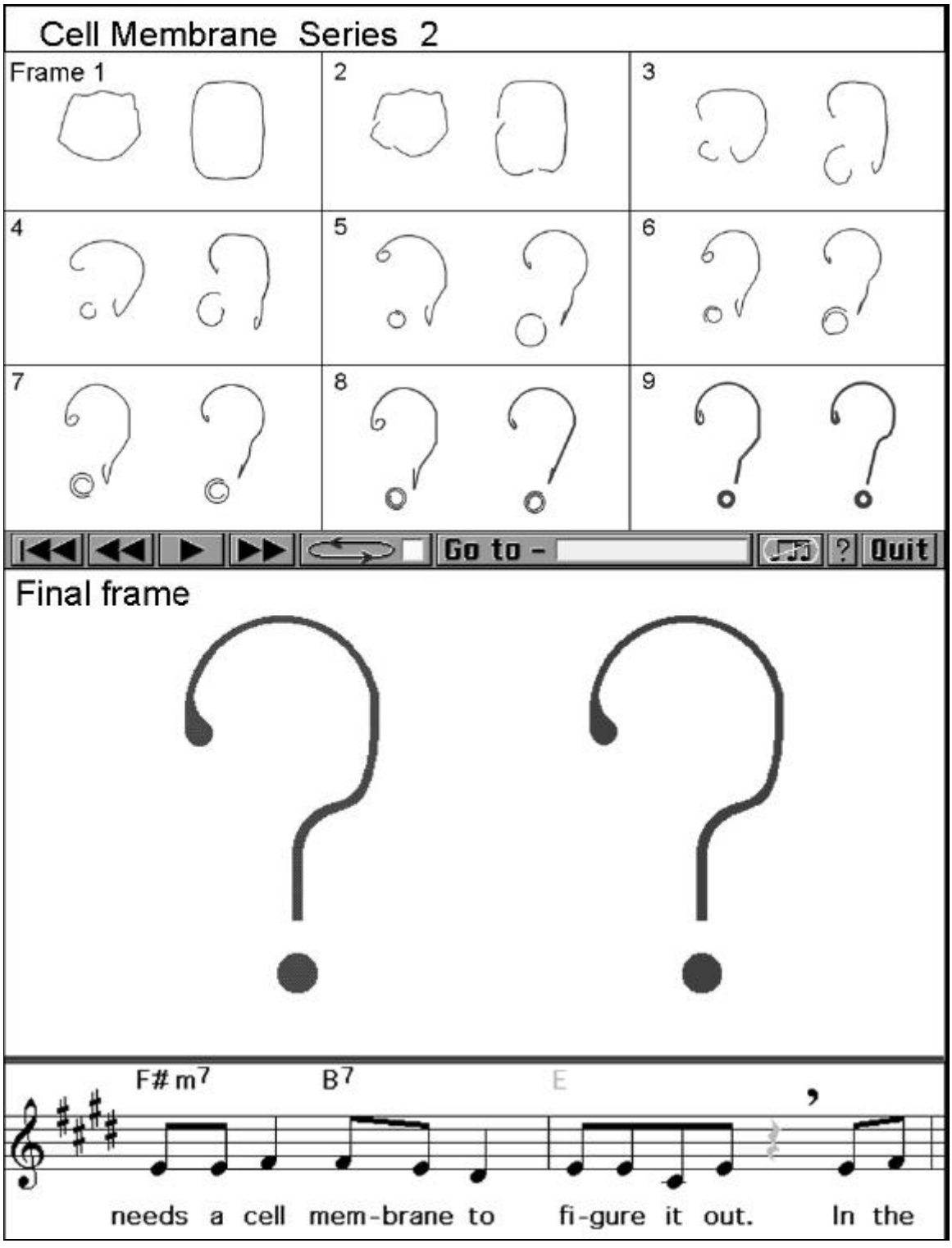


Figure 7 Cell Membrane 2

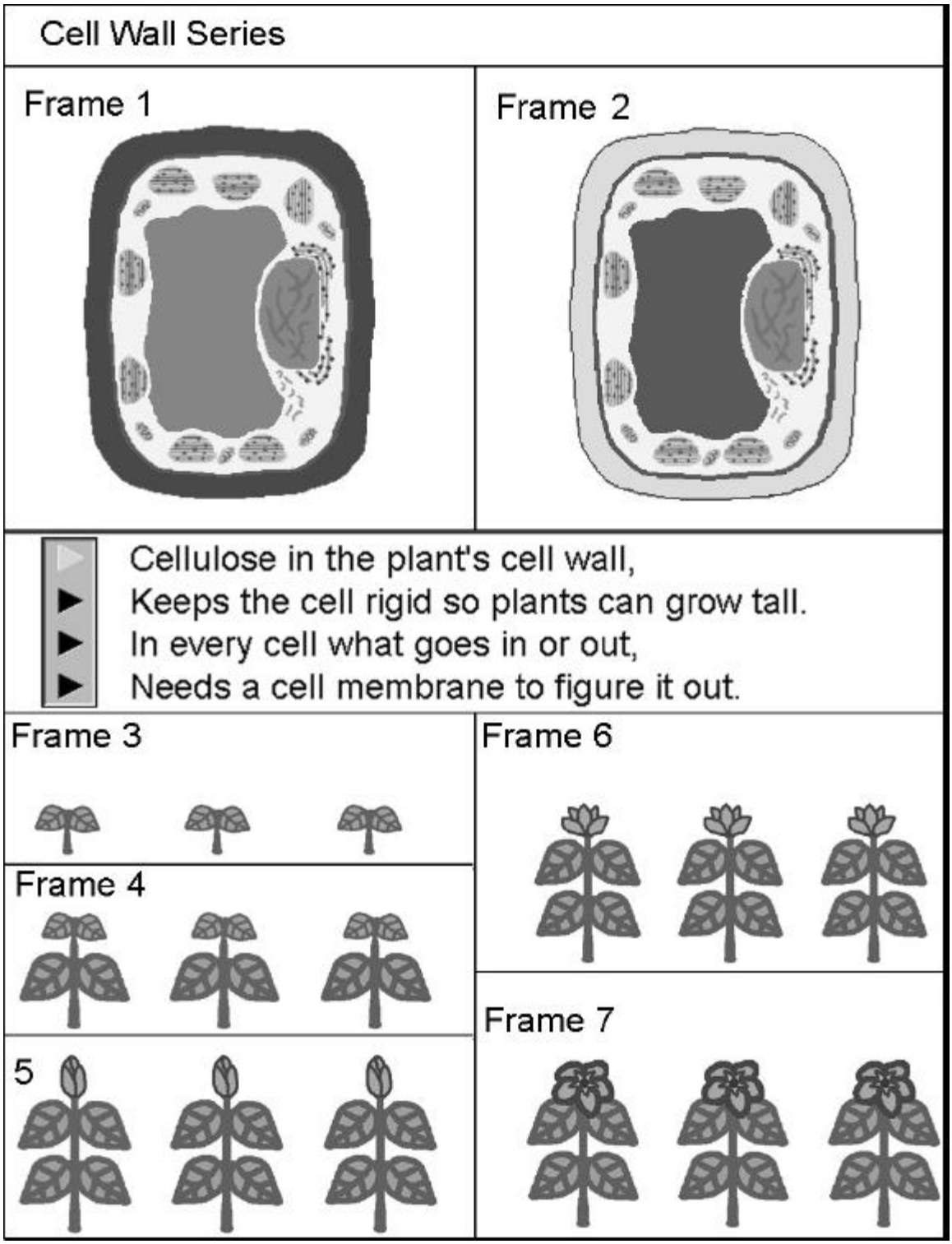


Figure 8 - Cell Wall

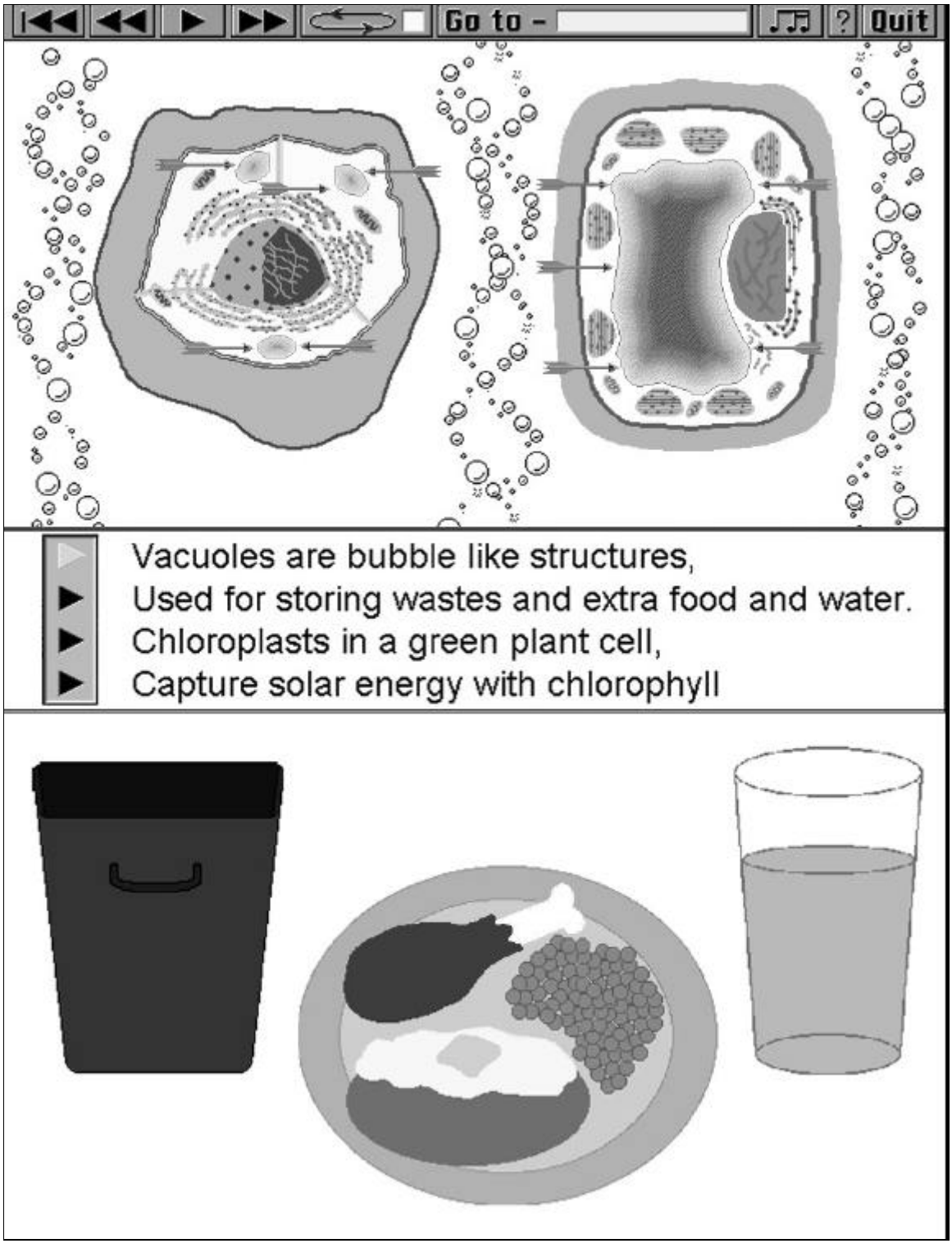


Figure 9 - Vacuoles

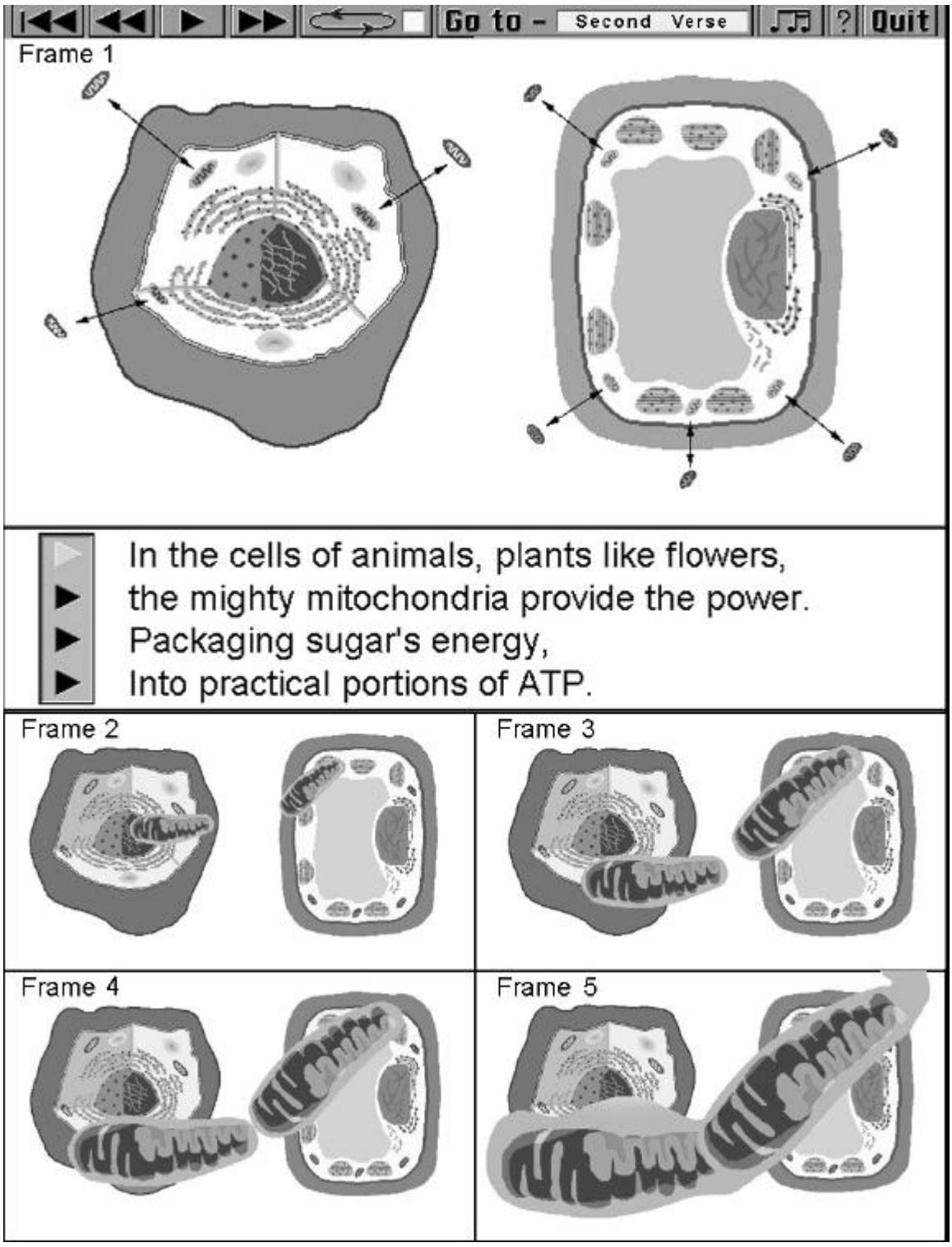


Figure 10 -Mitochondrion I

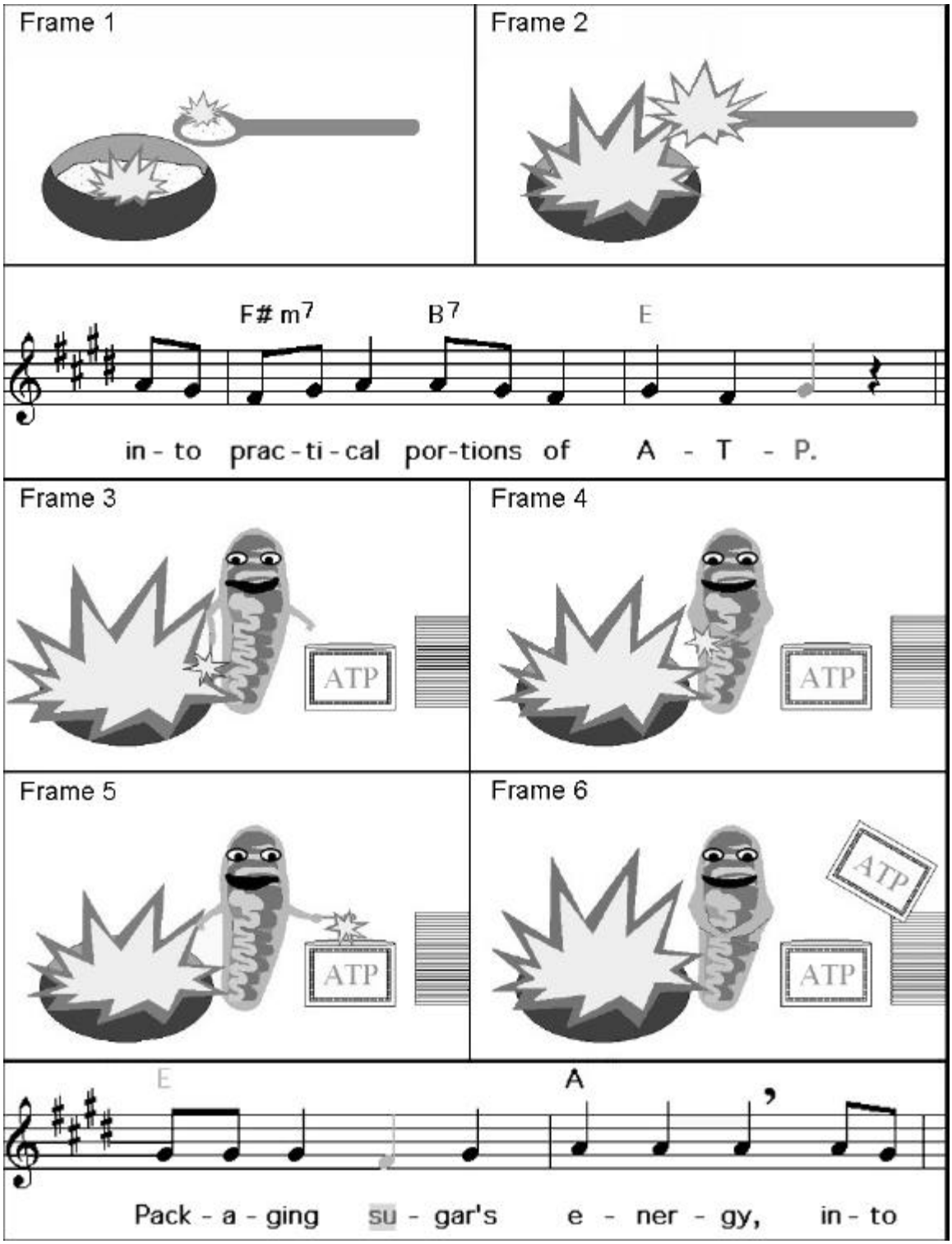


Figure 11 - Mitochondrion II

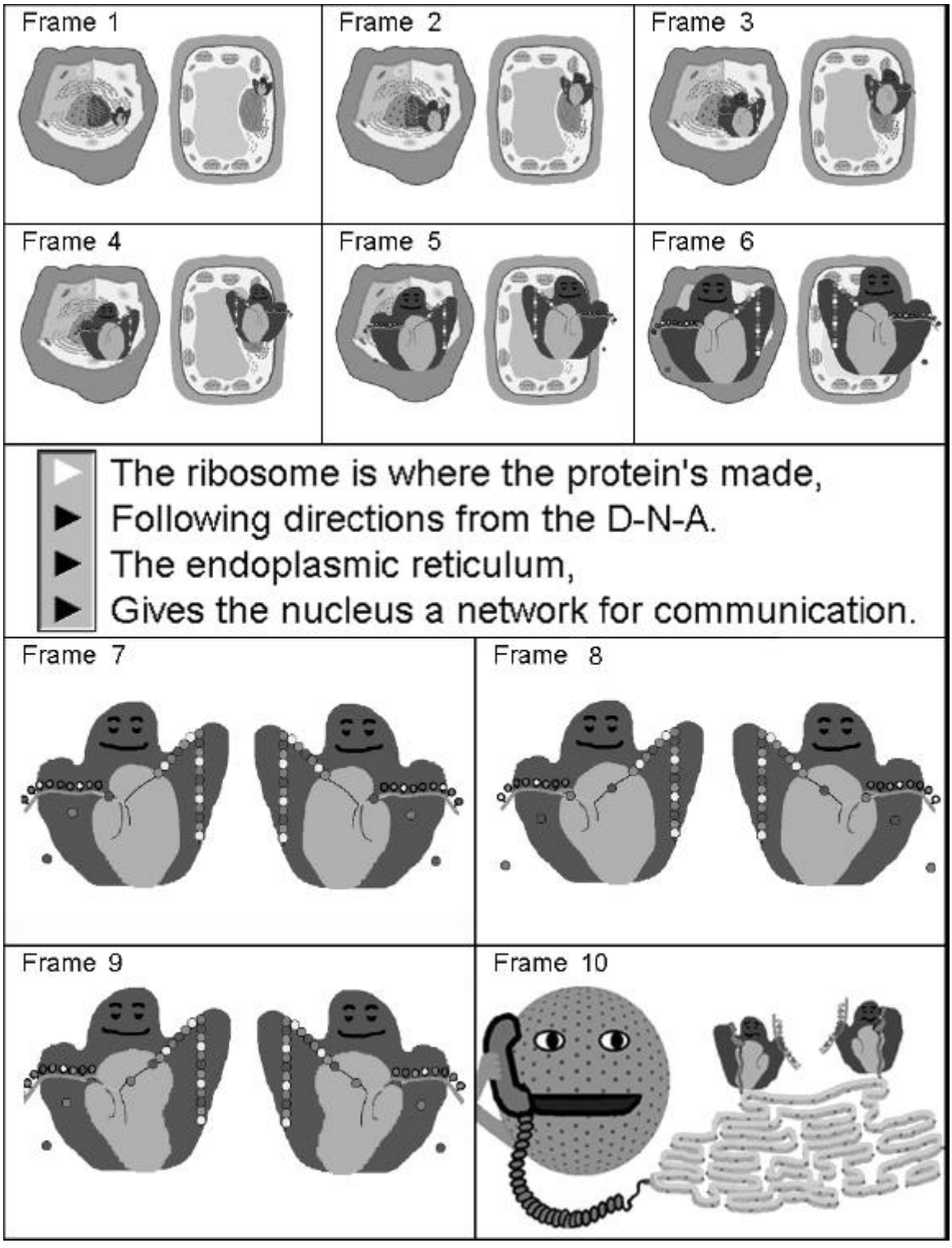


Figure 12 - Ribosome

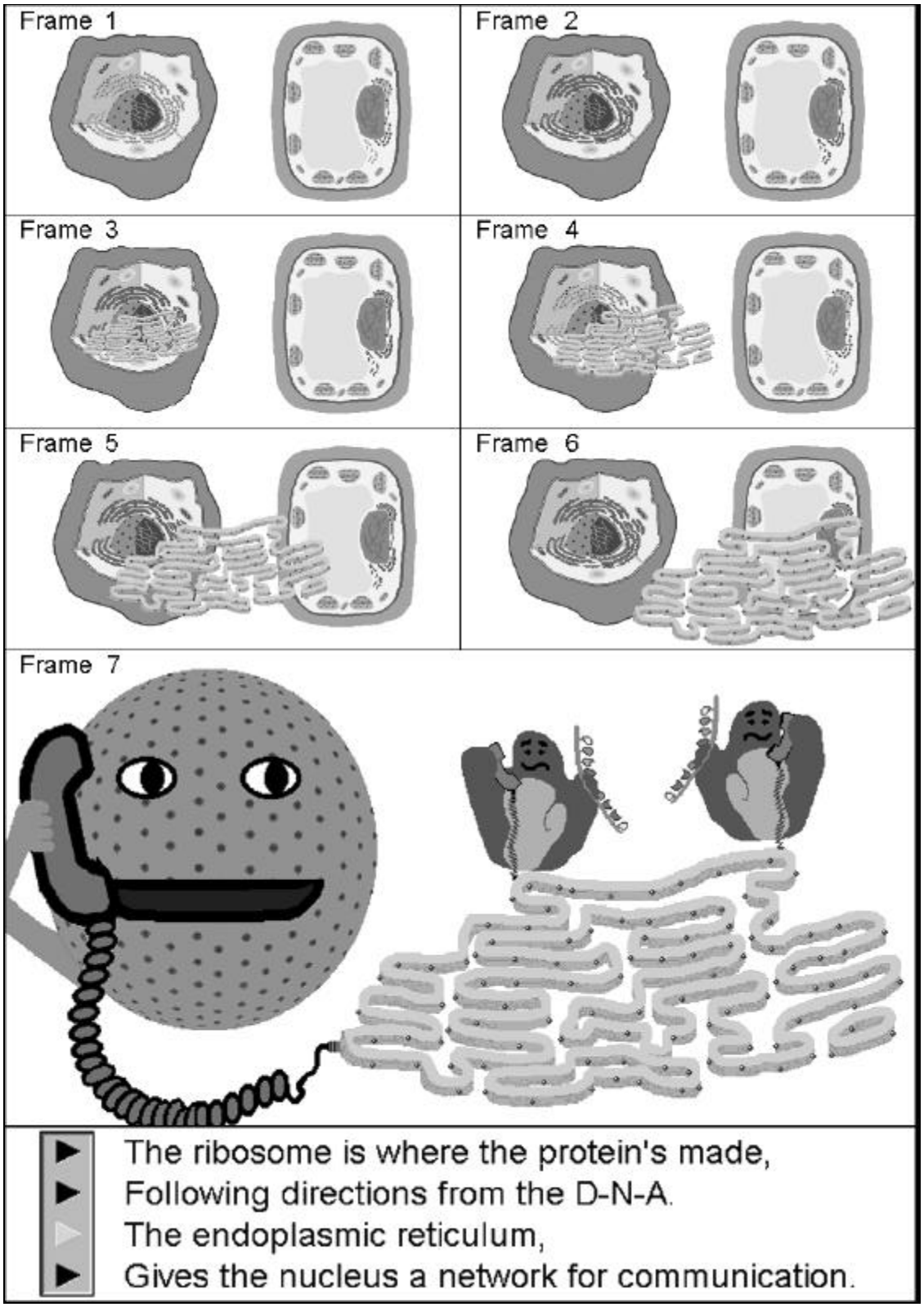


Figure 13 Endoplasmic Reticulum

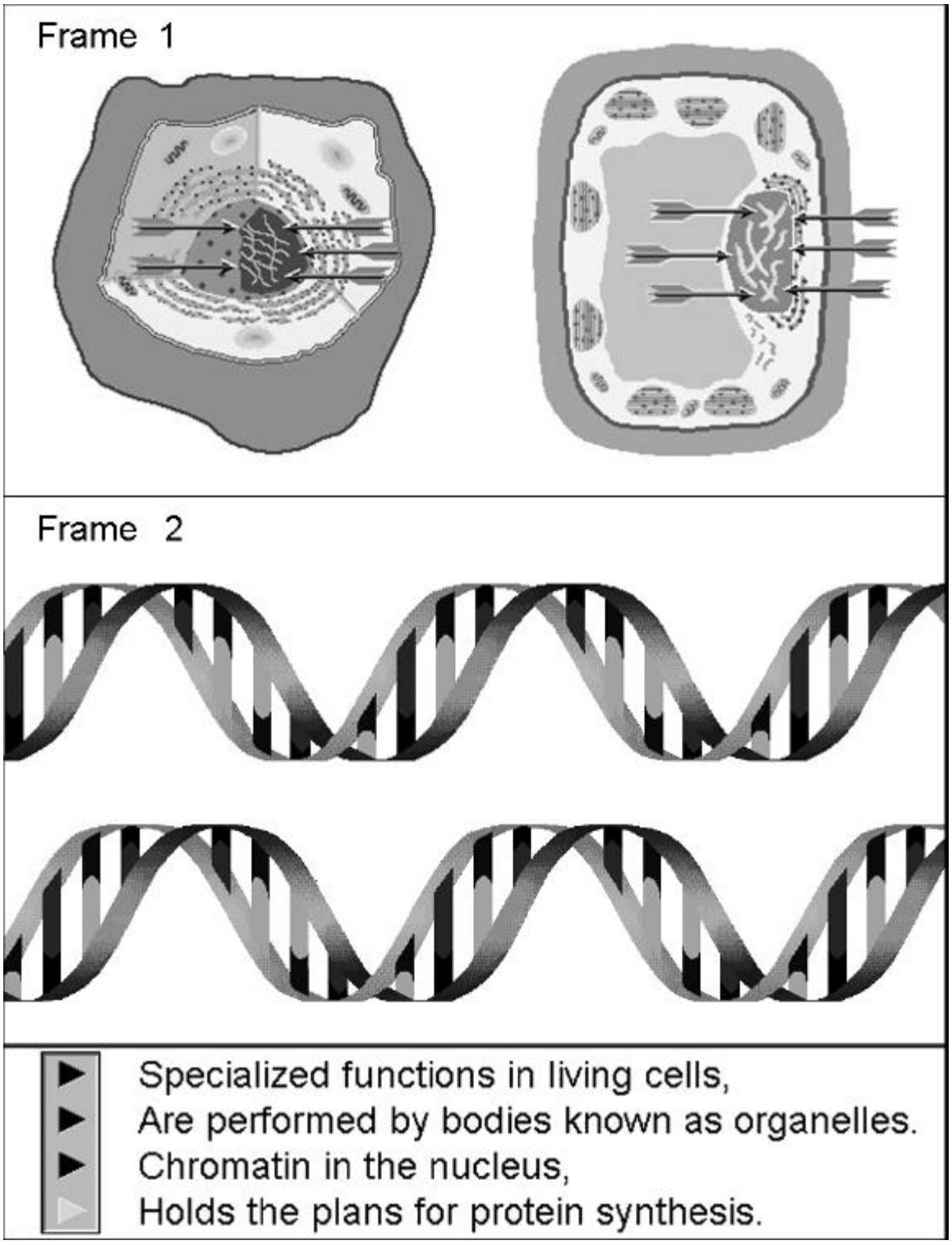


Figure 14 - Chromatin

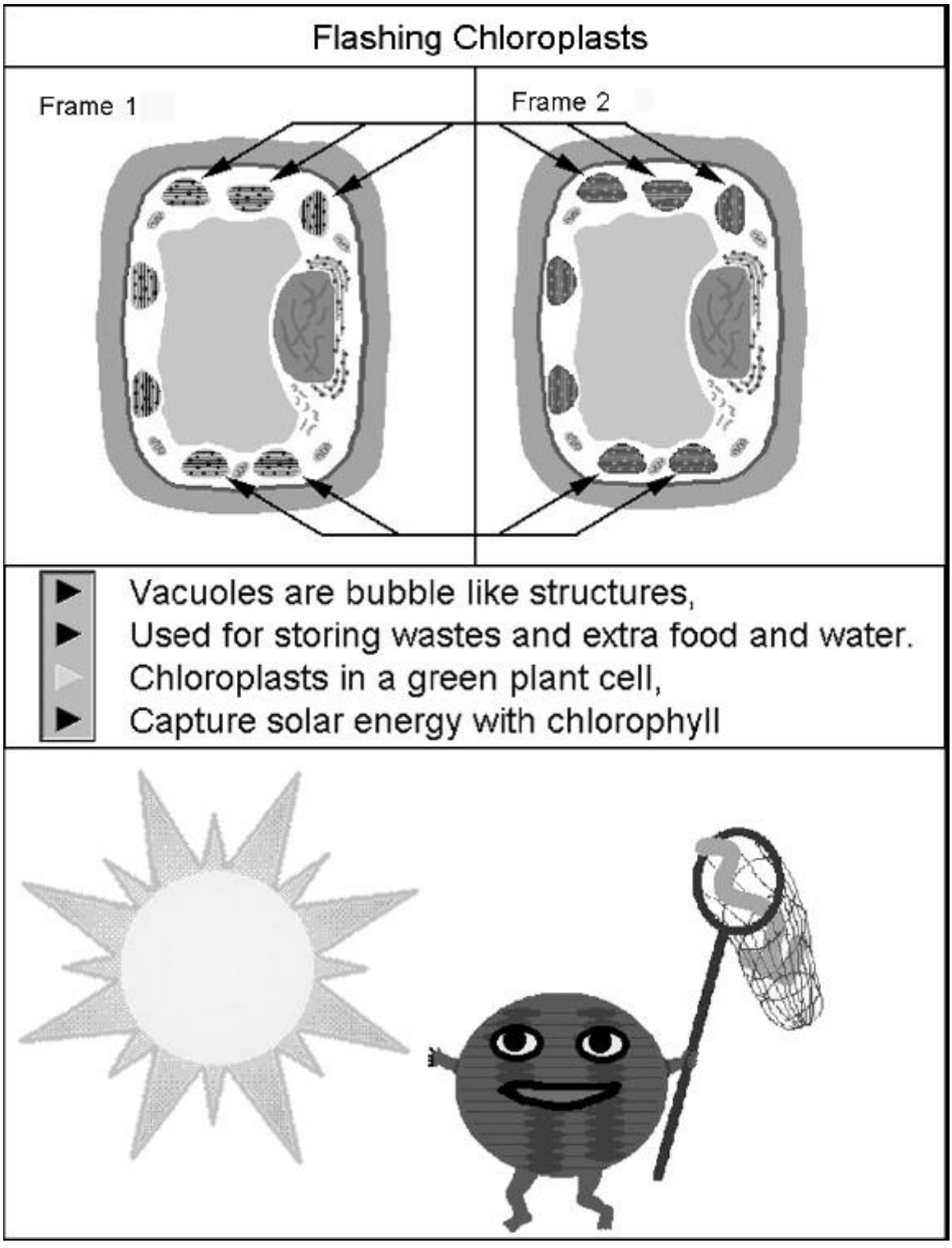


Figure 15 - Chloroplasts

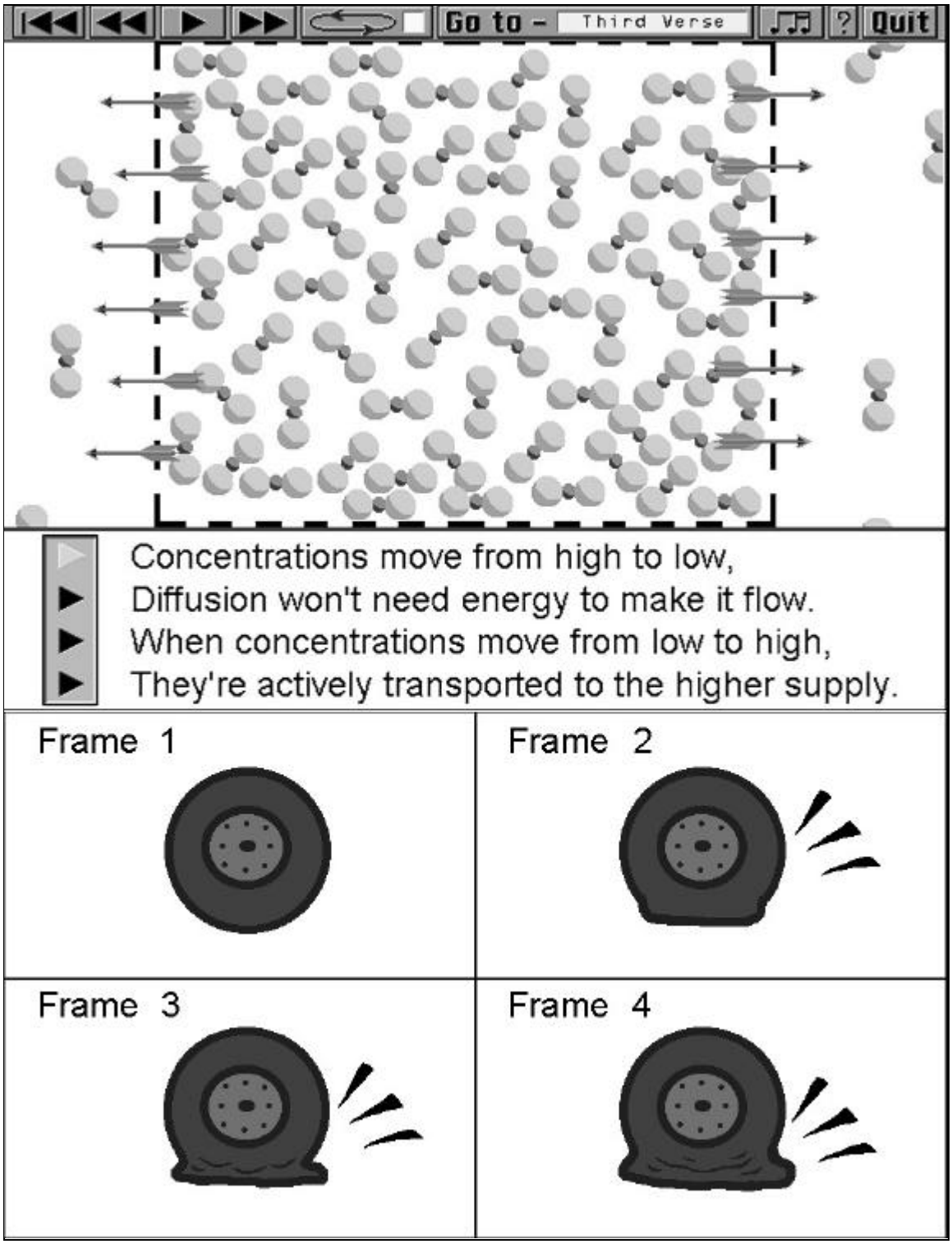


Figure 16 - Diffusion

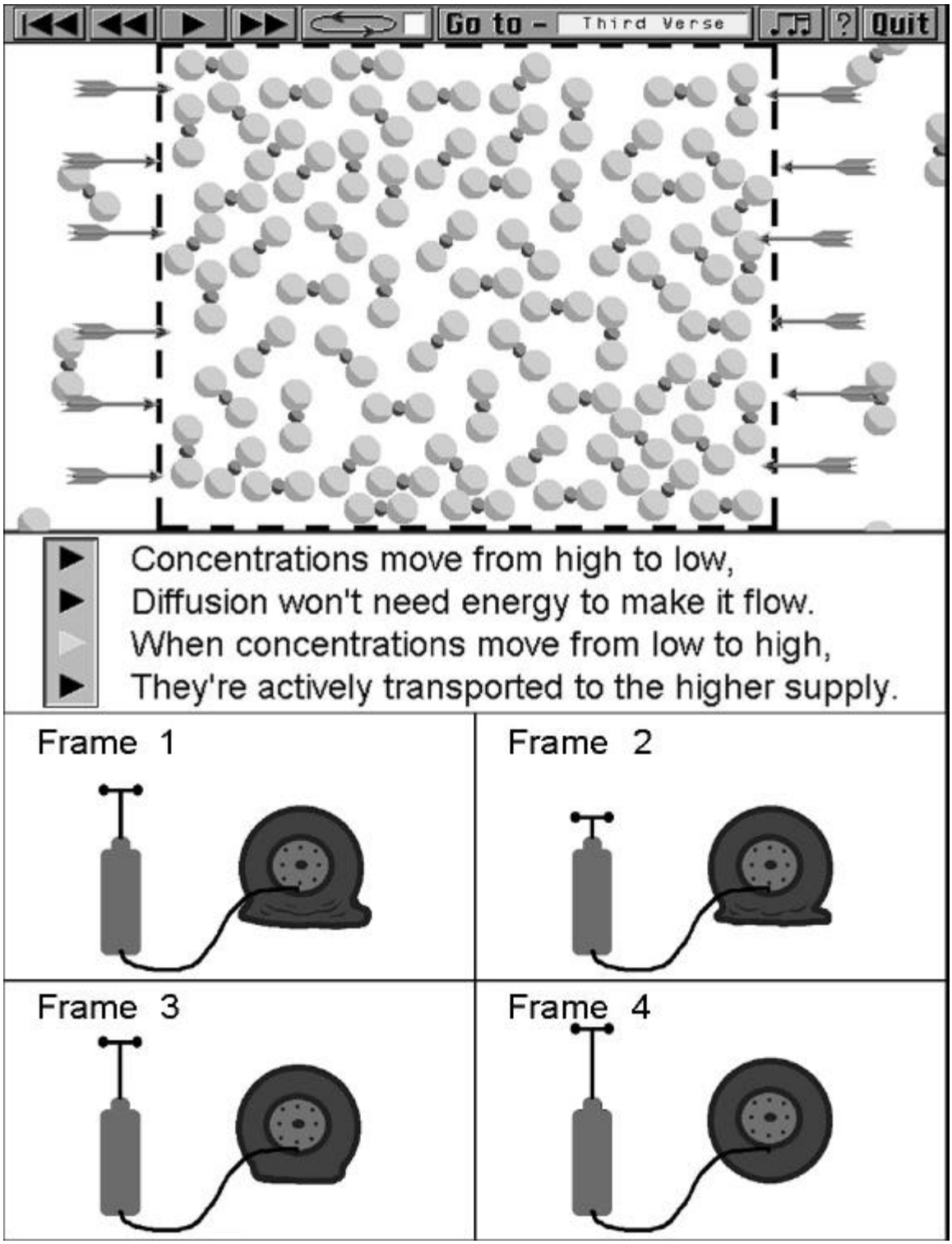


Figure 17 - Active Transport

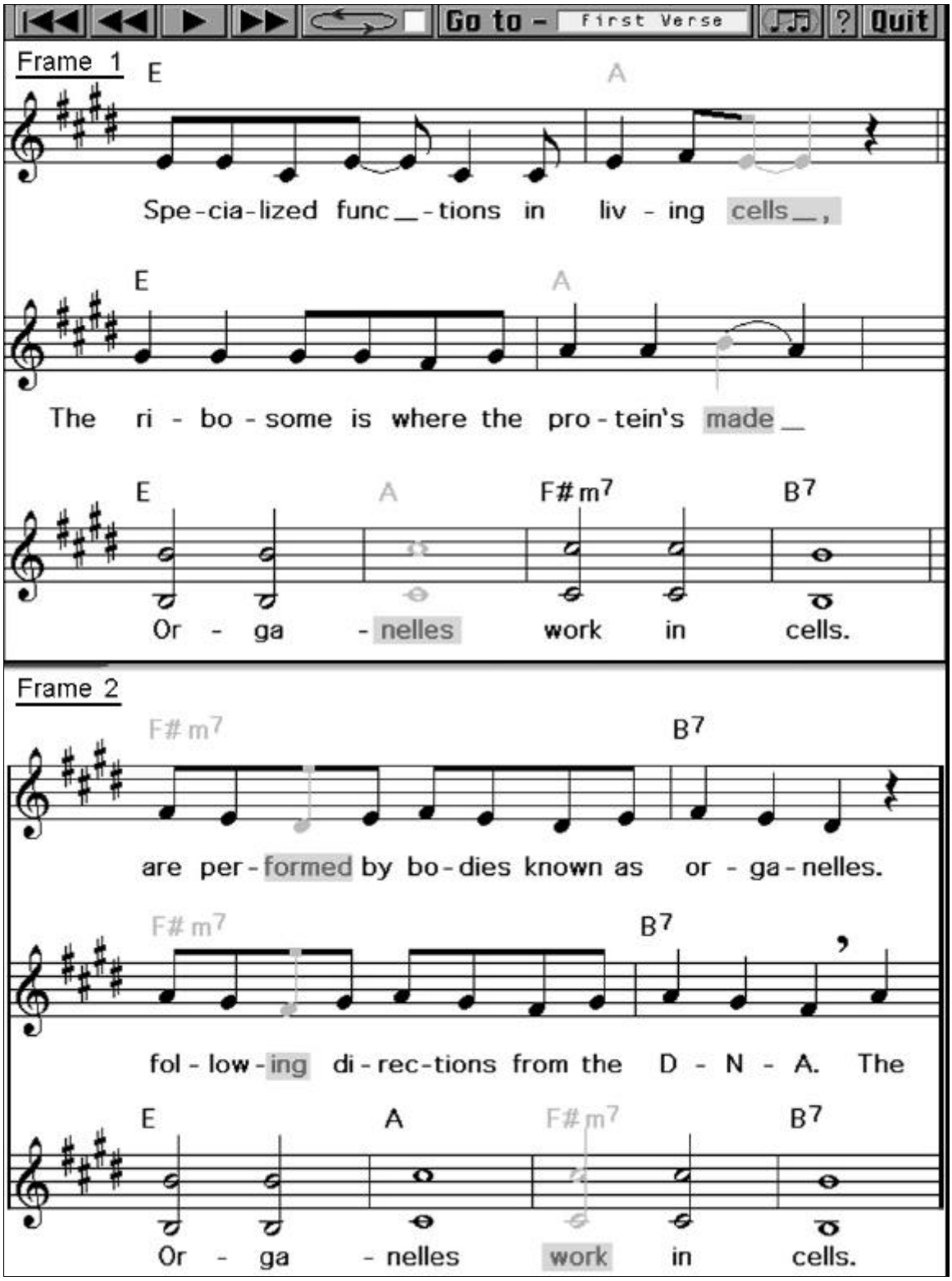


Figure 18 -Three Part Harmony

Chapter 2. Evaluation Methods

Initially, the "CellSong" CAI program was reviewed by instructional design, subject matter and teaching experts and educational psychologists. The program was then reviewed by subject sophisticates in a one-to-one procedure. Finally, the program was field tested with several groups of middle school students. The purposes, participants, procedures and results for each of the formative evaluations were distinct. They occurred in different locations and involved different people. These steps were self-inclusive; each step of the formative evaluational led to conclusions that were acted upon before the next step was initiated. To avoid confusion, each procedure will be described and discussed in the chronological order in which it took place. A summative discussion follows.

Expert Review - Participants/Procedures

Scholarly.

Seven faculty members from the Department of Teaching and Learning at Virginia Tech, one faculty member from the Music Department (also at Virginia Tech) and one independent instructional designer provided the initial formative evaluation of the "CellSong" program. Their collective areas of expertise include cognitive and behavioral educational psychology, instructional systems design, middle school music curriculum, middle school science curriculum, and instructional program evaluation. These expert evaluations led the designer to make several changes in the program as noted.

Before the "CellSong" program was developed, the song "Cell's Organelles" was presented to a science curriculum and the music curriculum expert. The song was initially presented to the music curriculum expert as adjunct to a middle school music curriculum. The following year, the designer presented a cassette of "Cell's Organelles" with eight other songs to one of the science curriculum experts at Virginia Tech.

After a working model of the program was developed, it was presented to two members of the faculty from the Department of Teaching and Learning. Shortly afterwards it was presented to two more faculty members along with the music curriculum expert. The designer then individually demonstrated the program to the independent instructional

designer and the remaining faculty member. Comments regarding the potential efficacy of the song were elicited and constructive feedback was noted.

Administrative.

Following the incorporation of the suggested change in the program's design, the evaluational team, composed of the developer, Karl Kimmel, and his associate, Teresa Kimmel, secured approval from Virginia Tech's Institutional Review Board (IRB) to perform an investigation utilizing human subjects. (IRB forms are included in Appendix E.) The evaluation team then presented the program to three district superintendents and their curriculum specialists from two different rural counties (populations 4,800 and 13,176) and one larger county (population 74,000). The administrators were all enthused by the program. When asked, none of the superintendents or curriculum specialists offered any suggestions for ways to improve the program. The small-town assistant superintendent in charge of research projects warned that his system would not allow the program to be evaluated in their schools if it appeared the testing was oriented more toward "research" than "education." Each district's administrator suggested a contact person or a prospective teacher to contact within a specific school. At this point, the evaluational team went to the schools to secured permission to approach the teachers or contact person from each individual school's principal.

The Trenches.

A colleague of the design team established a program with a large middle school to help train teachers evaluate educational software. The middle school had a sixth grade class of about 600 students. The contact person there was the Director of Gifted education. (The large middle school was located in the same district as the small town superintendent.) The colleague invited "CellSong's" evaluational team to meet the director.

After viewing the program, the director set up meetings with a biology teacher, a music teacher and five seventh grade students. At the second meeting with the director,

she asked the evaluation team to play the program for the eight Special Education and Gifted teachers who were already in her office. The evaluation team discussed the program with the teachers and recorded their criticisms. On March 5, 1998, the director arranged for the evaluation team to meet with a science and music teacher in her office. The team presented the program to the teachers and recorded the conversation on tape (see Appendix F for the transcript of the dialog).

The evaluation team presented the program to five seventh grade students in the director's office. Each student was shown the program and interviewed individually in the director's small office while their biology class completed an assignment. The students interviewed had all covered the biological material covered in the song (a subject-sophisticates review). They were presented first with a sung (musical) version of the program and then a spoken (non-musical) version of the program. The evaluator observed the students as they watched the two versions of the program. In this one-on-one review the students were then asked a series of questions. The results were recorded by the evaluator and are displayed in Appendix G by item.

Results - Expert Review

Scholastic.

Two experts agreed that the displayed musical notation might distract some learners from the biology curriculum objectives. One expert felt that the notation might facilitate other types of learning. In response, the designer of the program added a button that toggled text with a musically-notated display (see Figures 2 and 4).

The two content experts (and all the biology teachers) questioned during the evaluation agreed that the content was accurate, complete, up-to-date and if learned would help learners recall the requisite information. The science curriculum expert at Virginia Tech stated in regard to the song, "Cell's Organelles," "… this song is about the parts of the cell, but many concepts can be drawn from it, and it could be used in the classroom as a support for concept development. It is appropriate at the 5th-7th grade level, in my opinion." (Bentley, 1997)

Trenches.

Although the Director of Gifted education was enthusiastic about the program, she requested that several changes made in the evaluational instruments. As a result, the directions of the recall test were modified so that students were immediately informed that the test's purpose was to evaluate the program's success, not the students'. The underlined blanks for answers were uniformly sized (see Appendix D - Aided Recall Test). The interviews with eight Special Education and gifted teachers pointed to the need for developing a Macintosh version of the program. This need was confirmed in subsequent interviews with science, music and Special Education teachers as well as a rural elementary school librarian.

The science teacher reported that the program would be useful for her class and requested a copy of the recall test. The music teacher was not as enthused about using the program in her class. However, she mentioned that the program addressed the National Standards of Learning for Music that students sing music written in two and three parts (NAFME, 1998).

The seventh grade students (subject-sophisticates) appeared to be interested in the presentation as evidenced by their visual focusing on the activity on the computer monitor. The director later described these five students interviewed as being of average to gifted ability. One student was described by the director as being mildly learning disabled though highly intelligent. He was the only student to glance away from the computer's screen while the programs ran. The lack of focus occurred twice and only for a moment during the time the two programs ran -- a little over ten minutes.

The students felt that the content of the "CellSong" musical program would help them remember the biological material better. Two of the students thought that the non-musical program was easier to understand but harder to remember. One suggested that if he was not already familiar with the material, he would have liked to see the non-musical version before the musical one. Students requested that the notated version be displayed for at least the first three to five presentations if they were expected to learn to sing the

song. They agreed that the song would be easier to learn with the notation but “after a while it would get in the way.”

Small Group/Field Test Evaluation

Participants.

Fifty students from two rural southern schools, Location M and Location S, participated in the field study/small group evaluation. Subjects from Location M consisted of the students of a single fifth grade class from a very small rural elementary school (n = 12). The science teacher at Location M (mTeacher) stated that the six male and eight female students ranged from slightly below average to gifted with respect to academic ability. There was another fifth grade class in the school of unknown size that was made up of students of low ability. Two female students were absent for the delayed recall test because they were being recognized in a special honors ceremony off the schools' premises. All six male students and six female students filled out the attitude survey.

Location S consisted of the sixth grade life science classes from a larger southern rural elementary school. The teacher at Location S (sTeacher) stated that the twenty four male and fourteen female students (n = 38) were a “nice heterogeneous grouping.” The students ranged from very low to gifted, with respect to academic ability. All 38 students completed the aided recall test immediately after hearing the song for the fifth time. Eight males and six females from Location S filled out the attitudinal survey. Eight males and five female took the delayed retest of the original recall test. The teacher determined the sample of students based on whether or not the student had returned the Internal Review Board (IRB) permission slips at that point. The teacher stated that the sample represented a good mix of the academic ability of the whole class.

The science teachers at both schools were men in their late fifties. Each had more than ten years experience teaching middle school life science classes. Their teaching ability was highly regarded by both their district administrations. They both had established reputations for quickly mastering and readily utilizing innovative and experimental teaching methods. Prior to teaching at the elementary school, the science teacher at Location M

worked for seven years as a research biologist studying sheep reproduction. Additionally, he is musically talented and had considered pursuing a musical career before entering graduate school. He has a strong baritone voice and sings well. In contrast, the teacher at Location S stated that he was not musical and would not sing in public.

Procedures

Two questionnaires were developed to ascertain the teachers' and students' attitudes towards the program. An 11-item questionnaire (see Appendix H) was developed to determine the teachers' attitudes regarding the implementation, usability, and appropriate price for the program. A 40-item questionnaire (see Appendix I) was developed to determine the students' attitudes regarding various aspects of the program, their previous musical experience, and the relative novelty of the teaching strategy. A 16-item aided recall test (see Appendix D) was developed to determine whether students were able to recall the targeted verbal information. The students' regular life science teachers were expected to introduce and operate the program throughout the evaluation. Afterwards, these teachers were to administer the evaluational instruments. The evaluation team planned to be present throughout the evaluation. Constant changes in the classes' schedule associated with the end of the school year made this impossible. The team stayed in contact with the teachers by way of phone calls, email and visits to the sites.

During the class session immediately before exposing the students to the program, the teachers spent approximately 45 minutes familiarizing students with the various parts of the cell and assigned textbook readings for homework (see Appendix F). The teachers contacted the evaluation team each time they ran the program, either by email or telephone. One of the team members followed up with a telephone call or a personal visit to find out what happened.

Location S had a media specialist/librarian who set up the program to run on a 333Mhz Pentium computer attached to a 42 inch Sony monitor for the first three showings. The program was presented to the whole sixth grade class ($n = 38$). The students were told that they should sing along with the program but the teachers present

neither modeled the behavior nor required it. The students heard the program three times. At this point, only some of the students sang along with the program.

The teacher at Location S found that some male students became unruly during Thursday's large group presentation and reduced the effectiveness the program. He decided to present the program in smaller, more controllable groups. The following Tuesday, the students returned to their normal life science classes for their fourth and fifth exposure to the program. Immediately after their fifth exposure they were asked to respond to the aided recall test. Appendix D includes all the items presented on the recall test. Seven days later, the fourteen students who had brought in the signed IRB permission slips filled out the attitude survey and took the same aided recall test (test-retest).

In the three districts approached, the evaluational team installed the "CellSong" program on a single computer and explained its purpose. The functionality of the control buttons was demonstrated and teachers' questions were answered. The evaluation team then attempted to persuade the teachers to operate the controls themselves. Generally, the teachers, though impressed with the program, were uncomfortable operating the controls on their own and waited until the team left before experimenting.

The teacher at Location M, was the only classroom teacher that did not need to be coaxed into working the program by himself. His classroom had a new 333Mhz Gateway 2000 Pentium Computer with a 17 inch monitor that he set up himself (except for the connection to the Local Area Network). Although he seemed to lack a good deal of basic knowledge of the Windows 95 Operating System, mTeacher had a good feel for the computer's capabilities. He was comfortable playing with it, using or adding peripherals (even when it meant opening the up the case and adding a PCI card), or experimenting with new educational uses for the computer. He was the only classroom teacher the team encountered who allowed students to freely access a computer; essentially unrestricted before and after class.

Location M used block scheduling in which each class session lasted for an hour and a half, meeting alternately on Monday, Wednesday and Friday of one week and Tuesday/Thursday of the next. Along with 45 minutes spent introducing the biological

information, mTeacher spent 15 minutes introducing the musical symbols to the students before exposing them to the program. At the beginning of next class session, he introduced the program to the class. Sitting slightly diagonal to the monitor, with his class gathered round, mTeacher and the class sang along with the program. At the beginning of the next class meeting, the teacher and students sang along with the program two more times. Four days later, the students completed the aided recall test. Ten days later the class filled out the attitude survey.

Several times during the course of the program's runtime, mTeacher found it necessary to "re-sync" the program with the song. He was also occasionally asked by students to pause or repeat certain sections of the program so as to clarify either a musical or biological question. Neither he nor the students had any difficulty understanding the program's controls. The teacher at Location S reported that the computer animation never lost its sync to the music. Neither teacher used the help, loop or "music denotation" buttons when they used the program for the class.

Data Sources

Several evaluational instruments were specifically prepared for this study. These included an aided recall test (Appendix D) and an attitude survey (Appendix I) for the students; and an attitude survey for the teachers (Appendix J). All three were "pen-and-pencil" style questionnaires. After the testing, the evaluational team went to Location M to watch the class use the program. All of the questionnaires were proctored by the regular classroom teacher and graded by the evaluational team.

The aided recall test (Appendix D) was a short-answer, fill-in-the-blank style test. It consisted of sixteen questions. Twelve questions asked for the specific nomenclature used in the song (e.g. the name of the organelle). Four questions dealt with concepts reinforced by the song (e.g., the difference between active transport and diffusion). The test was not timed. All of the students at Location S took the aided recall test immediately after seeing the "CellSong" program. Fourteen of these students took the same recall test

seven days later. Ten of the students at Location M took the aided recall test four days later.

The student attitude survey consisted of three short-essay questions, five short-answer questions, thirty-three questions arranged in a four-point Likert scale, and an item asking the students to draw a picture of a typical plant cell. The first item (1) sought to determine the student's prior knowledge of cellular physiology. (See Appendix J - Items Divided by Classes.) Three more items (4, 13 and 14) were used to ascertain the degree of novelty of this music mnemonic strategy among the students. Four items (24, 25, 26 and 27) were utilized to determine the students' prior musical experience.

Thirteen items were employed to assess which aspects of the program the students found enjoyable. Of these, four items (5, 6, 7 and 8) were concerned with the students reaction to the actual song, three (9, 10 and 11) dealt with their reaction to the animation, and six items (12, 19, 21, 22, 23 and 40) ascertained student reaction to the program as a whole. Five items (2, 3, 15, 16 and 17) were devoted to determining the students attitude toward the musical mnemonic strategy. Three items (31, 32 and 38) were employed to find out the students' perception of the relative success of the program within their classroom. Three items (28, 29 and 30) functioned to pinpoint the students' perceived focus of attention while they learned the song. Four items (18, 20, 36 and 37) were used to describe the memory methods favored by students (metacognition). Three items (33, 34 and 35) were used to assess student perception of how well they learned to sing the song. Finally, two general, broad performance items (39 and 41) were used to help summarize what students had learned as a result of the program use.

Appendix H includes the 16 short answer items presented to the teachers in order to assess their attitude towards the program. The first nine of these items were concerned with the implementation of the program within the classroom. The next three dealt with the content. There was one item that dealt with the usability of the program, one item that dealt with availability of necessary hardware and one item that asked what the teacher's perceived the program should cost.

Chapter 3. Results

Responses from the Aided Recall Test (Appendix D)

The data indicate that students at Location M (n = 10) answered an average of 51% of the sixteen items correctly on the aided recall test. Students at Location S answered an average 15% of the items correctly on the initial test (n = 38) and 10% of the items correctly on the delayed retest (n = 13). The students' scores for each test item were examined to determine the programs effectiveness in helping students learn the targeted verbal information. These scores are presented in Table 1. The Item Analysis Graph (see Figure 19 at end of chapter) was created primarily to display the difference in scores across locations. The graph shows the percentage of students correctly answering each item for the three administrations of the aided recall. The dark gray bars represent the scores of the sixth grade students at Location S immediately after experiencing the program for the fifth time. (The students did not sing along with the program time and mTeacher did not model the singing behavior.) The black bars represent the responses to the same items on the retest taken five days later of the thirteen students from Location S. The light gray bars represent the item scores of the ten students from Location M. (The students and the teacher at Location M sang along with the program.)

At Location M (n = 10), the student's scores (M = 8.20, SD = 3.33) on the delayed recall test appear to conform to a normal distribution. Two students answered between zero and five items correctly, six students answered between six and ten items correctly, and two remaining students answered between 11 and 16 items correctly. Both sets of scores at Location S appear to be positively skewed. In the initial recall testing (n=38), 33 students answered between zero and five items correctly and six students answered between six and ten items correctly (M = 2.42, SD = 2.65). In the delayed retest at Location S (n=13) 12 students answered between zero and five items and one student answered between six and ten items correctly (M = 1.62, SD = 2.47).

Table 1

Aided Recall Test - Percent correct responses by item and location/test

Location S

	Item							
	1	2	3	4	5	6	7	8
Initial Test	29%	13%	11%	13%	45%	21%	21%	13%
Retest	15%	8%	0%	8%	23%	8%	23%	0%

	Item							
	9	10	11	12	13	14	15	16
Initial Test	16%	5%	0%	13%	11%	16%	8%	8%
Retest	15%	8%	0%	8%	8%	23%	8%	8%

Location M

	Item							
	1	2	3	4	5	6	7	8
Test	90%	90%	60%	30%	80%	40%	50%	50%

	Item							
	9	10	11	12	13	14	15	16
Test	60%	30%	30%	70%	60%	30%	10%	40%

Location S
Initial Test n = 38
Retest n = 13

Location M
Test n = 10

Subject Key by Item

1. Organelles	6. Endoplasmic Reticulum.	11. ATP Synthesis
2. Nucleus	7. Organelles	12. Diffusion
3. Protein (synthesis)	8. Cell wall	13. Active transport
4. Protein	9. Cell membrane	14. Vacuoles
5. Nucleus	10. Mitochondria	15. Chloroplasts
		16. Chlorophyll

Although there seemed to be a gender effect in the attitudinal survey, the data in Table 2 indicate that this effect appeared to be smaller in the actual test scores. The four females student who took the test at Location M scored an average of 10.75 out of 16 items correctly. The six males scored and average of 6.5 correctly. The students at Location S seemed to answer fewer items correctly. In the initial testing, the 14 females students who took the test at Location S scored an average of 1.93 correctly. The 24 males scored and average of 2.71 correctly. In the delayed retest, the 5 females student who took the test at Location S scored an average of 1.17 out of 16 items correctly. The 8 males scored an average of 2.00 items correctly.

Table 2
Students' mean scores and standard deviations
on aided recall test by gender

		Female	Male	Totals
Location S Recall Scores	M	1.93	2.71	2.42
	SD	2.23	2.87	2.65
Location S Retest Scores	M	1.17	2.00	1.62
(7 days later)	SD	1.33	3.21	2.47
Location M Recall Scores	M	10.75	6.50	8.20
(5 days later)	SD	3.30	2.17	3.33

Note. Sixteen possible correct.

Table 3 presents data relative to the differences in the percentage of items correctly recalled between the test and the retest by the specific students at Location S. The test and retest were administered seven days apart. Once the students learned specific information with the music mnemonic, they tended to remember it. No student answered new or different items correctly after the delay. The similarity of scores is represented graphically by Figure 19 (located at the end of the chapter).

Table 3

Percentage correct test and retest scores at Location S by student

	Student Number						
	1	2	3	4	5	6	
Test	38	19	13	6	0	0	
Retest	31	0	13	0	0	0	
	Student Number						
	7	8	9	10	11	12	13
Test	0	0	13	56	25	6	0
Retest	0	0	6	50	13	0	0

Responses from the Student Attitude Questionnaire (Items classed in Appendix J)

The data given in Table 4 indicate that both the material covered and the teaching strategy were novel to the students. They reported having little prior knowledge of cellular physiology before learning the song as indicated by the mean score of 1.65 (SD = 0.75) calculated across locations and gender. Seventeen of the 26 students surveyed (at both locations) knew they were going to learn a song about cells (M = 2.81, SD = 1.13). Five of the 12 students from Location M and 5 of the 14 students from Location S reported that teachers used music mnemonics to help them remember information learned in class (M = 2.42, SD = 1.16). None of the students

had been asked by a teacher to write a song or a rap about something they were supposed to remember (M = 1.35, SD = 0.49).

Table 4

Mean scores and standard deviations across items related to novelty (method and subject) by gender

Item #		Location S			Location M			Total		
		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Method										
4. I knew I was going to learn a song about cells.	M	2.67	2.88	2.79	3.33	2.33	2.83	3.00	2.64	2.81
	SD	1.51	1.25	1.31	0.82	0.82	0.94	1.21	1.08	1.13
13. Teacher's use songs and raps to help memory.	M	2.67	1.50	2.00	2.17	2.33	2.25	2.42	1.86	2.12
	SD	1.37	1.07	1.30	0.98	0.52	0.75	1.16	0.95	1.07
14. Teacher's ask us to write songs or raps to help memory.	M	1.33	1.13	1.21	1.50	1.50	1.50	1.42	1.29	1.35
	SD	0.52	0.35	0.43	0.55	0.55	0.52	0.51	0.47	0.49
Totals										
Novelty of method Total (4, 13, 14)	M	2.22	1.83	1.95	2.33	2.06	2.19	2.28	1.93	1.93
	SD	1.31	1.20	1.24	1.08	0.73	0.92	1.19	1.02	1.11
1. I knew about all the cell parts and processes before I learned the song. (Novelty of subject)	M	1.50	1.25	1.36	1.50	2.50	2.00	1.50	1.79	1.65
	SD	0.84	0.46	0.63	0.55	0.55	0.74	0.67	0.80	0.75

Note. Judgments were made on 4-point scale (1 = strongly disagree, 4 = strongly agree) .

The data in Table 5 indicate differences in the students' attitudes by gender and location towards the strategies used in developing the program. All of the students at Location M felt that the song (M = 3.33, SD = 0.49) and animation (M = 3.67, SD = 0.49) helped them remember the targeted information. About half the students at Location S felt that the song (M = 2.64, SD = 1.16) and animation (M = 2.36, SD = 1.01) helped them remember. Eight of the 11 students responding to the item at Location M liked it when the teacher used a song to help them remember (M = 3.09,

SD = 0.83). Eleven of the 12 students reported liking this method better than the other memory methods teachers used (M = 3.83, SD = 0.41). Four of the six female students at Location S liked their teachers to use songs to help them remember (M = 2.67, SD = 1.03) and all the female students liked learning songs better than other memory methods teachers use (M = 3.83, SD = 0.41). Most of the males at Location S did not like did not like it when their teacher used songs to remember information (M = 2.00, SD = 1.31). Most of the students at both locations said they would like learning songs provided they liked the style of music in which the songs were written (M = 2.81, SD = 1.71).

Table 5

Mean scores and standard deviations across items related to students' attitudes towards strategy

Item #		Location S			Location M			Total		
		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
2. The song helped me remember the cell parts and processes.	M	2.67	2.63	2.64	3.33	3.33	3.33	3.00	2.93	2.96
	SD	1.21	1.19	1.15	0.52	0.52	0.49	0.95	1.00	0.96
3. The animation helped me remember the cell parts and processes.	M	2.17	2.50	2.36	3.83	3.50	3.67	3.00	2.93	2.96
	SD	0.75	1.20	1.01	0.41	0.55	0.49	1.04	1.07	1.04
15. I like when teachers use songs or raps.	M	2.67	2.00	2.29	3.17	3.00	3.09	2.92	2.38	2.64
	SD	1.03	1.31	1.20	0.98	0.71	0.83	1.00	1.19	1.11
16. I like learning songs better than other memory methods.	M	3.83	2.25	2.93	3.83	3.33	3.58	3.83	2.71	3.23
	SD	0.41	1.49	1.38	0.41	0.82	0.67	0.39	1.33	1.14
17. I like songs but only when I like the style of music.	M	2.67	2.75	2.71	3.00	2.83	2.92	2.83	2.79	2.81
	SD	1.37	1.28	1.27	1.10	1.17	1.08	1.19	1.19	1.17
Liked strategy Total (2, 3, 15, 16, 17)	M	2.80	2.43	2.59	3.43	3.21	3.32	3.12	2.75	2.92
	SD	1.10	1.26	1.20	0.77	0.77	0.78	0.99	1.14	1.09

Note. Judgments were made on 4-point scale (1 = strongly disagree, 4 = strongly agree) .

The scene when the organelles walk to work in the cell with lunch boxes was most frequently reported as being the students favorite (see Appendix I). The data in Table 5 indicate additional differences in student attitudes towards the animation and music used in the program by gender and location. Most of the students liked the characters in the animation (M = 3.13, SD = 1.06). All the female students and most of the male students at Location M liked the harmony (M = 3.42, SD = .067), beat of the song (M = 3.50, SD = 0.80) as well as the song as a whole (M = 3.25, SD = 0.97). After hearing the song, they felt they wanted to learn it (M = 3.25, SD = .87). At Location S, all of the female students liked the animation (M = 3.67, SD = 0.52), most liked the beat (M = 2.67, SD = 1.37) and harmony (M = 3.17, SD = 0.75) in the song and wanted to learn it after hearing it (M = 3.00, SD = 1.10). About half of these the students liked the song (M = 2.36, SD = 1.39). Most of the male students at Location S, did not like the harmony (M = 2.00 1.07, SD = 1.07) or the beat of the song (M = 2.00, SD = 1.33), and after hearing it, did not want to learn it (M = 1.88, SD = 1.13). These male students' opinion were split on the animation (M = 2.63, SD = 1.06).

All the students at Location M felt the song presented the right amount of information (M = 3.75, SD = 0.45). All of the female students and most of the male students at Location M felt the program held their attention (M = 3.42, SD = .067). Most of the students at Location M found the program an interesting and entertaining way to help them remember the targeted information (M = 3.55, SD = 0.69). Most of the students at Location S felt the song presented the right amount of information (M = 3.00, SD =1.11). Four of the six females students at Location S liked the program and felt the program held their attention (M = 2.67, SD = 1.03). They split on whether it was an interesting way to help remember the targeted information (M = 2.67, SD = 1.03). Most of the male students at Location S did not like the program (M = 2.28, SD = 1.25).

Table 6

Mean scores and standard deviations across items related to students' attitudes towards program by gender.

Item #		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
										Total
Liked Song										
5. After hearing the song, I wanted to learn it.	M	3.00	1.88	2.36	3.50	3.00	3.25	3.25	2.36	2.77
	SD	1.10	1.13	1.22	0.55	1.10	0.87	0.87	1.22	1.14
6. I liked the song.	M	2.50	2.25	2.36	3.67	2.83	3.25	3.08	2.50	2.77
	SD	1.38	1.49	1.39	0.52	1.17	0.97	1.16	1.34	1.27
7. I liked the harmony.	M	3.17	2.00	2.50	3.67	3.17	3.42	3.42	2.50	2.92
	SD	0.75	1.07	1.09	0.52	0.75	0.67	0.67	1.09	1.02
8. I liked the beat.	M	2.67	2.00	2.29	3.83	3.17	3.50	3.25	2.50	2.85
	SD	1.37	1.31	1.33	0.41	0.98	0.80	1.14	1.29	1.26
Liked animation										
9. I liked the animation.	M	3.67	2.63	3.07	3.50	3.00	3.25	3.58	2.79	3.15
	SD	0.52	1.06	1.00	0.55	0.89	0.75	0.51	0.97	0.88
10. I liked the characters in the animation.	M	3.17	2.71	2.92	3.20	3.60	3.40	3.18	3.08	3.13
	SD	1.17	1.38	1.26	0.84	0.55	0.70	0.98	1.16	1.06
Liked program										
12. The program held my attention.	M	2.67	2.38	2.50	3.83	3.00	3.42	3.25	2.64	2.92
	SD	1.03	1.19	1.09	0.41	0.63	0.67	0.97	1.01	1.02
19. I found this an interesting and entertaining way to help me remember.	M	2.67	2.43	2.54	3.80	3.33	3.55	3.18	2.85	3.00
	SD	1.21	1.27	1.20	0.45	0.82	0.69	1.08	1.14	1.10

Table 6 (continued)

Item #		Location S			Location M			Total		
		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Liked program (continued)										
21. I liked singing along with the program.	M	1.50	1.38	1.43	3.17	2.50	2.83	2.33	1.86	2.08
	SD	1.22	1.06	1.09	0.41	0.84	0.72	1.23	1.10	1.16
22. The song presented enough information.	M	2.67	3.25	3.00	4.00	3.50	3.75	3.33	3.36	3.35
	SD	1.03	1.16	1.11	0.00	0.55	0.45	0.98	0.93	0.94
23. The song presented too much information. *	M	1.17	2.25	1.79	1.17	1.00	1.08	1.17	1.71	1.46
	SD	0.41	1.16	1.05	0.41	0.00	0.29	0.39	1.07	0.86
Totals										
Liked the song Total (5, 6, 7, 8)	M	2.83	2.03	2.38	3.72	3.06	3.39	3.25	2.46	2.83
	SD	1.13	1.20	1.23	0.46	0.94	0.80	0.96	1.21	1.16
Liked the animation Total (9, 10)	M	3.42	2.67	3.00	3.36	3.27	3.32	3.39	2.92	3.16
	SD	0.90	1.18	1.11	0.67	0.79	0.72	0.78	1.06	0.96
Liked program Total (12, 19, 21, 22)	M	2.38	2.35	2.36	3.70	3.08	3.38	3.00	2.70	2.83
	SD	1.13	1.31	1.22	0.47	0.78	0.71	1.09	1.16	1.14
Liked program Total (5 - 10, 12, 19, 21, 22)	M	2.77	2.28	2.48	3.62	3.10	3.36	3.20	2.60	2.89
	SD	1.14	1.25	1.22	0.52	0.84	0.75	1.00	1.20	1.12

Note. Judgments were made on 4-point scale (1 = strongly disagree, 4 = strongly agree)

* The question caused the ordering of the scale to be reversed. The item was not used in total.

The data in Table 7 indicate additional differences by gender and location in the student's perception of their own effort and efficiency in learning the song. Eleven of the 12 students at Location M reported that they tried hard to sing the song well (M = 3.50, SD = .067). They all reported they tried hard to learn the words of the song so they could sing them better (M = 3.58, SD = 0.51). Eleven of these 12 students also reported that doing better on a test about organelles was the incentive for their efforts (M = 3.67, SD = .065). Only three of the 14 students from Location S reported trying hard to sing the song (M = 1.86, SD = 1.10). Most did not try to learn to learn the words to sing the song better (M = 1.93, SD = 1.27), but claimed they learned the words in order to pass a test about organelles (M = 2.86, SD = 1.10).

Eleven of the 12 of the students at Location M (M = 3.50, SD = 0.67) and about half the students at Location S (M = 2.50, SD = 1.16) thought that learning the song would help them perform better on a test about the parts of the cell. Eleven of the 12 students at Location M (M = 3.17, SD = 0.83) and about a third of the students at Location S (M = 2.08, SD = 1.00) felt they had a good grasp of the material covered. At Location M, five of six female students and two of the three responding male students felt they would remember material learned in the song longer than if they had read it or heard it in a lecture (M = 3.00, SD = 1.22). At Location S, most of the male students reported that they would not remember material better when they learned it in a song (M = 1.88, SD = 1.25). Among the responding female students, three of the four reported that they would remember the material longer if it was presented in a song (M = 2.75, SD = 1.26).

Table 7

Mean scores and standard deviations across items related to students' focus and metacognition.

Item #		Location S			Location M			Total		
		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Student Focus										
28. I tried hard to sing the song well.	M	2.17	1.63	1.86	3.67	3.33	3.50	2.92	2.36	2.62
	SD	1.17	1.06	1.10	0.52	0.82	0.67	1.16	1.28	1.24
29. I tried hard to learn the words so I could sing them better.	M	2.00	1.88	1.93	3.67	3.50	3.58	2.83	2.57	2.69
	SD	1.26	1.36	1.27	0.52	0.55	0.51	1.27	1.34	1.29
30. I tried hard to learn the words so I could pass a test about organelles.	M	2.67	3.00	2.86	4.00	3.33	3.67	3.33	3.14	3.23
	SD	1.37	0.93	1.10	0.00	0.82	0.65	1.15	0.86	0.99
Student focus Total (28, 29, 30)	M	2.28	2.17	2.21	3.78	3.47	3.58	2.83	2.69	2.81
	SD	1.23	1.24	1.22	0.43	0.64	0.60	1.21	1.20	1.22
Metacognition										
18. I think learning this song will help me do better on a test.	M	2.83	2.25	2.50	3.67	3.33	3.50	3.25	2.71	2.96
	SD	0.98	1.28	1.16	0.52	0.82	0.67	0.87	1.20	1.08
36. I feel I really understand the material covered.	M	2.00	2.13	2.08	3.00	3.33	3.17	2.60	2.64	2.63
	SD	0.82	1.13	1.00	1.10	0.52	0.83	1.07	1.08	1.06
37. I feel I will remember this material longer than if I read it in a textbook or heard it in a lecture.	M	2.75	1.88	2.17	3.00	3.00	3.00	2.90	2.18	2.52
	SD	1.26	1.25	1.27	1.10	1.73	1.22	1.10	1.40	1.29
Metacognition Total (18, 36, 37)	M	2.57	2.08	2.26	3.22	3.21	3.24	2.92	2.54	2.70
	SD	1.02	1.18	1.13	0.94	0.89	0.90	1.02	1.22	1.14

Note. Judgments were made on 4-point scale (1 = strongly disagree, 4 = strongly agree) .

Table 8 reports data that indicate the students' feelings about how well their class learned the song, their perception of how difficult it was to run the program and how comfortable they felt singing the song individually. At Location M, 11 of the 12 students reported that the class sounded pretty good with more practice (M = 3.17, SD = 0.58). A third of the students felt that the class needed more practice before the song would sound okay (M = 2.67, SD = 0.98). About half of the students found it difficult to hold their part when the song broke into harmony (M = 2.50, SD = 1.17) but 10 of the 12 students reported they could hold their part even if they sang it alone (M = 3.33, SD =0.78). Half of the female students (M =2.17, SD = 0.98), and five of the six male students (M = 2.83, SD = 0.98) wanted to try to sing the song in smaller groups. Half of the female students (M = 2.50, SD = 1.05), and the three responding male students (M = 4.00, SD = 0.00), felt comfortable running the program if their teacher was preparing another class activity.

At Location S, students felt that the class did not start to sound better with repeated rehearsals (M = 1.79, SD = 1.19). In fact, the class had stopped singing along with the program by the third repetition. Almost half of the students felt that addition practice would not improve their performance of the song (M = 2.50, SD = 1.29). Most of the students reported that it was difficult to hold their own part when the song broke into harmony (M = 1.70, SD = 1.25). After five repetitions, 10 of the 12 responding students reported they still could not hold their own part (M = 1.42, SD = 1.00). None of the students wanted to sing the song in smaller groups (M = 1.17, SD = 0.39). Eight of the responding thirteen students reported not feeling comfortable running the program if the teacher was preparing another class activity (M = 1.91, SD = 1.38).

In their responses to the "Teacher's Program Evaluation Questionnaire" (see Appendix H), both teachers reported feeling that their students were more comfortable working with computers than they were. The teacher at Location M stated, "Many of the students are as good with or better at computers then I am and wouldn't have any trouble running this program by themselves." The teacher at Location S responded, "Students generally find computers more intuitive than older teachers."

Table 8

Mean scores and standard deviations across items related to students' musical attitudes by gender

Item #		Location S			Location M			Total		
		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Implementation										
31. The class started to sound pretty good after a while.	M	1.83	1.75	1.79	3.33	3.00	3.17	2.58	2.29	2.42
	SD	1.33	1.16	1.19	0.52	0.63	0.58	1.24	1.14	1.17
32. We need to practice the song more before it will sound okay.	M	2.50	2.50	2.50	2.67	2.67	2.67	2.58	2.57	2.58
	SD	1.38	1.31	1.29	1.03	1.03	0.98	1.16	1.16	1.14
38. I could have run the module for the class while the teacher prepared another activity.	M	2.00	1.88	1.91	2.50	4.00	3.00	2.33	2.45	2.40
	SD	1.73	1.36	1.38	1.05	0.00	1.12	1.22	1.51	1.35
Learning song										
33. It was hard to hold my part.	M	1.00	2.00	1.70	2.33	2.67	2.50	1.89	2.31	2.14
	SD	0.00	1.41	1.25	1.37	1.03	1.17	1.27	1.25	1.25
34. Now, I think I can hold my part.	M	1.75	1.25	1.42	3.33	3.33	3.33	2.70	2.14	2.38
	SD	1.50	0.71	1.00	0.82	0.82	0.78	1.34	1.29	1.31
35. I would like to try to sing the song in smaller groups.	M	1.00	1.25	1.17	2.17	2.83	2.50	1.70	1.93	1.83
	SD	0.00	0.46	0.39	0.98	0.98	1.00	0.95	1.07	1.01
Totals										
Implementation Total (31, 32, 38)	M	2.13	2.04	2.08	2.83	3.07	2.94	2.52	2.44	2.47
	SD	1.36	1.27	1.29	0.92	0.88	0.90	1.18	1.23	1.20
Learning song Total (33,34,35)	M	1.27	1.48	1.41	2.61	2.67	2.61	2.10	1.92	2.03
	SD	0.90	0.95	0.92	1.14	1.18	1.13	1.23	1.17	1.19

Note. Judgments were made on 4-point scale (1 = strongly disagree, 4 = strongly agree).

Table 9 reports data identifying the students' prior musical experience. Of the seven students studying a musical instrument at Location M, four reported the desire for a part written for their instruments so they could play along with the program (M = 2.58, SD = 1.31). Of the nine students studying a musical instrument from Location S, three requested a part written for their instruments (M = 1.79, SD = 1.12). Interestingly, of the ten remaining students, five wanted parts written for the instruments they did not play. Also, half the girls at Location S stated they did not study music in school. As they actually did study music in school, it may be surmised that they stopped paying careful attention to the questionnaire by the time they reached item 27.

At Location M, the four students who reported singing in a choir appeared to score higher on the recall test (M = 10.3, SD =3.59) than the rest of the class (M = 6.83, SD = 2.56). The five students who studied musical instruments scored slightly lower (M = 7.80, SD = 4.08) on the recall test than the five students who did not study a musical instrument (M = 8.60, SD = 2.79). In the retest at Location S, none the four students who reported singing in a choir answered any items correctly. The students who did not study a musical instrument appeared to outscore (M = 2.50, SD = 3.54) the students who did study a musical instrument (M = 1.44, SD = 2.60).

Table 9

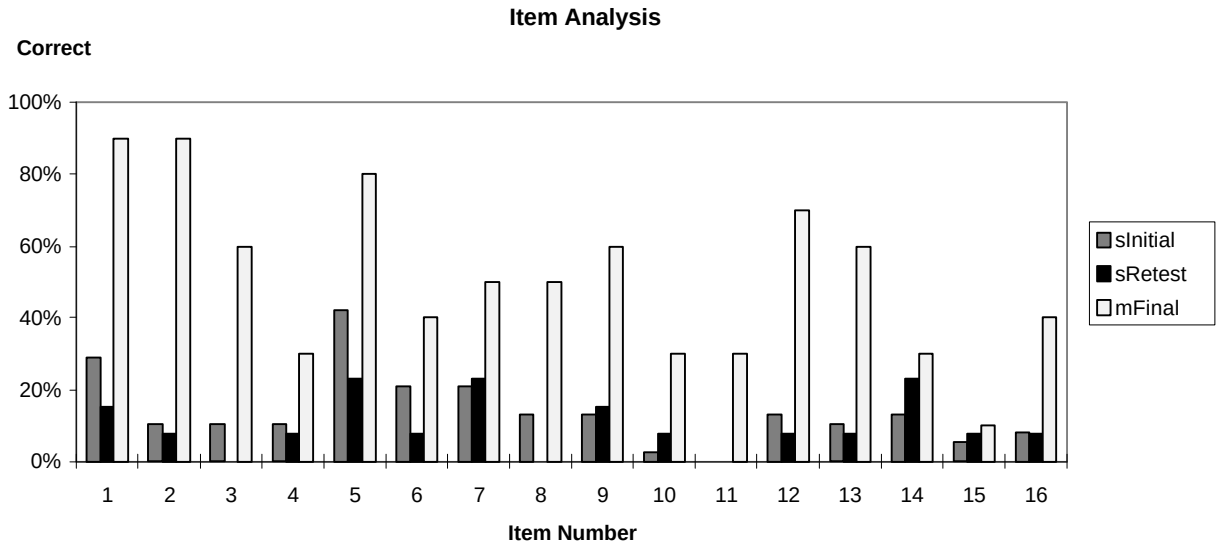
Frequencies mean scores and standard deviations across items related to students' music education by gender

		Location S			Location M			Total		
Item #		Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
24. Are you studying a musical instrument?	Yes	4	5	9	4	3	5	8	8	14
	No	2	3	5	2	3	7	4	6	12
25. Would you like a part written for your instrument?	M	2.00	1.63	1.79	3.00	2.17	2.58	2.50	1.86	2.15
	SD	1.10	1.19	1.12	1.10	1.47	1.31	1.17	1.29	1.26
26. Do you sing in a choir?	Yes	2	2	4	4	1	5	6	3	9
	No	4	6	10	2	5	7	6	11	17
27. Do you study music in school?	Yes	2	2	4	6	6	12	8	8	16
	No	4	6	10	0	0	0	4	6	10

Item 41 of the students' questionnaire asked students to draw and label a picture of a plant cell. Both teachers considered the drawing and labeling of the cell to be an important activity. The teacher at Location M had previously assigned the drawing of both plant and animal cells for homework and discussed the similarities of the musical and cellular systems in class. Students at Location M did not respond to these questions. Some students at Location S did draw pictures of the cell. (The evaluator's descriptions of these drawings are located in Appendix I.) Their value to this evaluation is questionable as some students used other sources while drawing them.

Although it was a new memory strategy, students from both locations mentioned songs as the way they most like to practice the things they have to remember. Other memory strategies students preferred included reading about the subject, writing the information over and over, outlining, note taking and computers. Suggestions for improving the program from students at Location S included changing the music or the singer, and making a textbook to accompany the program (see Appendix K).

When the evaluation team heard the class at Location M sing the song for the sixth time, they noticed that two of the males and one of the females sang in the appropriate rhythm but in a monotone voice. The teacher had not tried to split the students into groups and consequently, most students sang whatever part the teacher sang while the others sang the simplest part. The teacher reported that throughout the exercise, four girls in the class sang extremely enthusiastically. Two of the girls had scored the highest on the recall test (14 and 11 out of 16 correct). The other two were those absent on the day of the recall test to receive scholastic honor awards.



This figure graphically represents the percentage of students correctly answering each item on the aided recall test in the initial testing (n = 38) and retesting (n = 13) at Location S, and the testing at Location M (n = 10).

Subject Key by Item

1. Organelles	6. Endoplasmic Reticulum.	11. ATP Synthesis
2. Nucleus	7. Organelles	12. Diffusion
3. Protein (synthesis)	8. Cell wall	13. Active transport
4. Protein	9. Cell membrane	14. Vacuoles
5. Nucleus	10. Mitochondria	15. Chloroplasts
		16. Chlorophyll

Figure 19 - Item Analysis Graph

Chapter 4. Discussion

The purpose of this evaluation was to determine strength and weaknesses and report aspects of the "CellSong" program in need of improvement, to explore student attitudes about the program, to confirm the student's recall of the targeted information, and to find clues regarding the successful implementation of this program within a middle school classroom. Almost all the data collected was in line with what the contemporary empirical research predicted.

The aided recall test scores of student's at Location M where the teacher modeled or taught the singing strategy, seemed much higher than at Location S where the teacher did not model the strategy. The empirical mnemonic research predicts that the ability to recall information learned mnemonically endures. This longevity of recall is evidenced by the "Forgetting" graph and aided recall test-retest scores of the students at Location S (see Figure 20). Once the students learned an item, the memory seemed to endure.

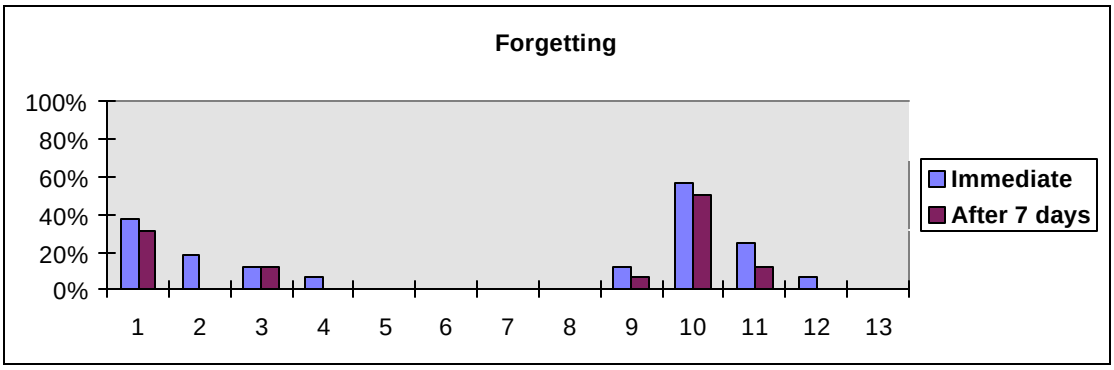


Figure 20. Forgetting Graph Illustrates the percent of items answered correctly on the aided recall test and retest for students at Location S

The item analysis graph (see Figure 19 at the end of the previous chapter) revealed

the students were confused about the difference between “chloroplasts” and “chlorophyll.” It was more surprising that more students did not remember what a mitochondria was or what it did. The song uses alliteration and assonance in presenting the mitochondria (“the mighty mitochondria provides the power”). The song is synched at that point with an animation of a mitochondria morphing into a muscled arm. The song dealt with “vacuoles” in a stanza with a weak end-rhyme: “Vacuoles are bubble like structures, Used for storing wastes and extra food and water.” Students at Location M answered both items (vacuoles and mitochondria) with approximately the same accuracy. Students at Location S were better able to recall “vacuoles” than “mitochondria.” According to Wallace and Rubin’s research (1991; 1988), the poetic devices should have helped students recall and the weak end-rhyme should have facilitated the recall of the word “vacuoles” less. This could have been caused by the small sample size or a confounding influence by the teacher. In preparing the class at Location M, mTeacher described the golgi bodies in a manner that might have overlapped with the students ability to recall the mitochondria. The teacher at Location S reported that “still teaches the idea of phagocytic and pinocytic vacuoles to 7th graders” (see Appendix L). It seems likely that classroom teachers need to explain some of the visual metaphors to the students in order for them to be understood and therefore effective in aiding recall.

This field test successfully demonstrated that when a new teaching strategy is used in ways contrary to previous empirical findings, it can effectively reduce achievement and encourage students to reject the new strategy. The student attitudes toward the program and their recall test scores seems to result from the location, or more specifically, the method used by the teacher to present the program. Using a music mnemonic to facilitate the recall of targeted information was a novel teaching strategy at both Location S and Location M. Empirical research predicts that new mnemonic strategies need to be taught to younger children (Gfeller 1982; 1983; Pressley & Dennis-Rounds, 1980; McGivern as cited by Pressley, Levin, and Delaney, 1982, p. 66-67; Pressley and Levin, 1978; Pressley, Samuel, Hershey, Bishop, & Dickinson, 1980; Miller, Levin, & Pressley, 1980; as cited by Pressley, Levin &

Delaney, 1982, p. 71-72) When the "CellSong" program was presented with the teacher singing along with the class as in Location M, both mTeacher and the students found the program an enjoyable and productive experience. Conversely, when the teacher at Location S, refused to sing along with the program, the students did not find the exercise particularly enjoyable or productive.

The teacher at Location S stated on the "Teacher's Program Evaluation Questionnaire," that "Sixth and seventh graders are peer influenced. If the right students like it then it will be useful." (See Appendix G - 1.1) When a member of the evaluational team asked sTeacher about his delivery of the program, he stated "I don't sing in front of people." It may be that peer influence was a primary factor responsible for the poor student performance on the aided recall test and their negative attitude toward the program; empirical evidence points to a lack of modeling by the teacher. Generally, listening to a song is not sufficiently engaging for a student to learn the lyric, particularly a lyric with odd or unfamiliar vocabulary. The song needs to be actively sung. Gfeller 's research (1982, 1983) demonstrated that the teacher needs to model the music mnemonic strategy. Like other educational strategies, as the student's familiarity and success with a learning technique increases, their resistance to this technique and need for external support will probably decrease.

The decision to rehearse the song exactly five times was influenced by Wallace's (1994) research in musical recall facilitation. Five rehearsals seems to give a normal distribution of student scores. Student scores on the aided recall test at Location M appear to follow a normal distribution. The distribution of the students' scores of the at Location S appear to be positively skewed, probably because the teacher did not model the strategy. The researchers' desire for a good distribution of scores is inconsistent with the educators' desire for student mastery of the subject matter. The appropriate number of student rehearsals of the program for mastery of subject matter contained within the program has not yet been determined. Obviously, more than five rehearsals are necessary if teachers desire 95% of their students to master more than 70% of the subject material covered by the program. If the musical

aspects of the program were also explored by the students' music teacher, there would be educationally relevant reasons for additional rehearsals of the song (see Appendix L for applicable music SOL's).

The teacher at Location S mentioned in an interview afterwards that different students did better on the aided recall test than usually do well on his tests and, that students usually doing well on his tests did not do as well as he expected. The evaluator discovered upon further probing that the sTeacher normally used recognition tests (multiple-choice, matching, and true-false). Aided or constructed response tests are harder (Sherman, 1998) and less biased by a student's culture or gender (Holmes, 1997) than recognition tests. It is therefore unclear whether the new strategy or the type of test (small sample or novelty) is the reason for the inconsistency of the students' scores.

Students at Location M and most of the female students at Location S tended to like the song, animation, and program as well as using the music mnemonic strategy. Sensitivity to the sTeacher's embarrassment, which inhibited the male teacher's singing along with the program, may have had something to do with the male students' general disdain for the method at Location S. This uneasiness may also be a contributing factor to why fewer students form Location S felt capable of running the program on their own.

Wallace (1994, Experiment 2) determined that vocal music experience sometimes had a facilitative influence on a subject's ability to recall a song's lyric. Indeed, at Location M, the students who sang in choirs scored higher than those who did not sing in choirs. It is unclear why the students who sang in a chorus or choir at Location M scored lower than their counterparts. While it is true that the samples were small, it is also possible that the some of the skills developed by singing in a chorus, (e.g., holding one's own vocal part against a counterpoint or harmony part) allowed these students to better ignore the noises emanating from the computer's speakers.

The difference in age and maturity between the fifth and sixth grade may also account for the older students' difficulty with the method. The teacher at Location S stated, "Second semester 6th graders (significant numbers) become surly, negative, rebellious and skeptical of both new and routine." The teacher at Location M reported no such problems in the conduct of his fifth grade class.

The major strength and weakness of this evaluation was that it was performed in regular classrooms by regular teachers. The penalty for this external validity was that the teachers and school administrators did not feel compelled to follow the evaluators' suggested procedures. The extracurricular activities associated with the end of the school year necessitated classes to be rescheduled. One teacher did not bother to model the strategy. In short, it would not be easy to replicate this evaluation.

The reward for this external validity was that the resulting issues seem indicative of what is to be expected when the programs similar to "CellSong" are implemented in classrooms. If the music mnemonic strategy is new to middle school students, the teacher will need to model the singing of the song or teach the students to rehearse it sub-vocally. The teacher will need to direct the students to an understanding of the visual and musical metaphors. The data does not support the assumption that students will reach this understanding on their own.

If the "CellSong" program is to function more independently of the classroom teacher, this evaluation has pointed to the need for an onscreen model. Male students held more negative attitudes toward the program than female students. It would be interesting to see if these differences in attitudes between the genders continued when a male vocalist, or male and female vocalists together, sang the song in the program.

More classrooms have access to computers. Integrating curriculum brings greater relevance and depth to the associated fields of study and is becoming more popular in middle schools. An effective musical mnemonic may be written about almost any subject that students have difficulty remembering. The "CellSong" program is a way to help students remember biology using a music mnemonic coupled with an animation. Similar programs may be developed for fields of knowledge where students

have large quantities of information to remember. Perhaps, the most important future research will be in determining whether “CellSong” and programs like it are effective in teaching the student populations that generally have difficulty remembering new information.

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Appendix A - Technical Specifications

The program was created in Director 6.0 and compiled as a “Projector” for Windows 95. The “Projector” refreshes the screen a maximum of 8 frames per second. The application requires a 133 MHz CPU, 256 colors, a CD-ROM, and a stereo sound-card. If “CellSong.exe” is placed on the hard drive it will take 3.12 Megabytes of hard drive space. This will allow it to run more efficiently than if run directly from the CD-ROM. However, if a fast CD-ROM is available (at least a 16X) the program may run directly from the CD. To date, there have been no problems encountered with video-cards that ran too slowly. The program also requires access to the song file (Karl.mov, 28 Megs). To run the program, this file must either be copied to the same folder as “CellSong.exe” along with the folder “Extras” or the CD, “CellSong,” must be left in the computer’s CD-ROM drive. A “Projector” compiled for Windows 3.1, for “CellSong.exe” is also saved on the CD.

See Appendix B for recording procedures and Appendix C for the models used in the development of the program.

Appendix B - Recording Procedures

Sound files were initially recorded digitally in stereo on a Dell Dimension XPS P133c computer equipped with a Creative Labs AWE32 sound card (16 bits sample size, 44.1 kHz sampling rate). They were then transferred to a Macintosh Quadra 840AV manipulated in Macromedia's SoundEdit 16 (Version 2).

The background instrumental music file for "Cell's Organelles" was initially recorded on the Macintosh Quadra 840AV using the "Performer 5.0" (Mark of the Unicorn, Inc.) MIDI sequencing program. The resulting MIDI file was transferred to the Dell computer. The MIDI file was then opened in Cakewalk Audio Pro 6.0 (Twelve Tone Systems, Inc.) a digital audio and musical sequencing so the vocals could be recorded. The instrumental sounds were provided via MIDI by a "Proteus MPS plus Orchestral" (E-MU) digital wave-form synthesizer. A Sennheiser 431 vocal microphone was run through a Portastudio's (Teac 144) mixing console directly into the AWE32 sound card to record the vocals on the Dell computer. A professional female vocalist was employed to record the four vocal tracks. A recording engineer, experienced with Cakewalk Audio Pro, was employed to record and mix the MIDI and vocal tracks.

Problems locating a suitable jack to patch into the Quadra's sound input necessitated mixing down the MIDI and audio tracks to cassette tape. The sound output of the AWE32 sound card, the Proteus keyboard and an ART digital reverb program were patched to the Portastudio's mixing console which was patched to an analog MCS stereo cassette deck. Cakewalk Audio Pro was used to control the audio and MIDI. The resulting cassette recording was fed directly back into the AWE32 sound card. The analog sound file was converted back to a digital sound file using Creative Wave (Version2.02) digital audio software (Creative Technologies LTD) and saved as a WAV file, which was then exported to the Quadra and saved in the QuickTime for Windows format using SoundEdit 16 (Version 2). The sampling rate was also reduced to 22,050 kHz to reduce demands on the final user's computer CPU. Amazingly, the conversions from the digital to the analog and back to the digital audio formats did not appear to reduce the sound quality of the recording.

Appendix C - Models for Program Development

"Edu-tainment" CD-ROM's frequently include songs. In some of these products, the song lyrics are constructed to facilitate recall of specific, educationally-valuable information and concepts (as with a music mnemonic). For example, the "JumpStart 2nd Grade" CD-ROM (Knowledge Adventure, Inc., 1996) offers songs as a reward for correctly putting the exact change in a virtual jukebox. Of the 16 songs offered on the jukebox, nine have educational lyrics. Seven of these utilize a music mnemonic strategy style. (Three are science related, three are about the parts of speech, and one deals with geography.) The two songs that deal with music follow a different (but effective) strategy: the lyric describes what is happening musically. There was no integration with the meaning of the songs' lyrics and the displayed animation so any facilitation of recall that these songs gave to subject's recall would appear to be a result of melodic and lyrical facilitation.

The "5 A Day Adventures" CD-ROM (Version 3) integrates digital video animation with nine of the ten songs' lyrics. (Produced by Interactive Design & Development, Inc., 1995) Of these nine songs, the digital video provides pictures and animations to reinforce the lyric and displays the lyric's text. The songs' musical notation was not displayed. As the CD's targeted audience appears to be early elementary school students and the songs were rhythmically complex, the displayed notation would have been more advanced than most of the students' ability to read music and therefore distracting. Although the primary purpose of the songs appears to be to heighten student motivation to learn about nutrition, this CD-ROM does makes light use of a music mnemonic strategy to reinforce student recall of the targeted information.

Rather than presenting songs, the "Kid's Classics" CD-ROM ("Sing-A-Long," Dr. T's Music Software, 1993-5) was designed to help children learn them. The songs used were standard children's repertoire, not educational music mnemonics (e.g., "Row, Row, Row your Boat," "Oh Susanna," "Oh, My Darling Clementine"). The program displayed

integrated animations and the song's lyrics simultaneously. There is a scrolling musical notation mode available in "Bigger Kid's Mode" (a la "follow the bouncing ball). This design was the model used to develop the "CellSong.exe" program. (See Appendix B for recording procedures.)

Appendix D - Cell Song Recall Test

***Name*_____**

Please share what you remember with us. You are not being evaluated, only the program. Fill in the blanks with the word(s) you feel best belongs.

1. The bodies, which perform specialized functions in living cells, are called _____ .

2. Chromatin is found in the _____ .

3. Chromatin holds the plans for _____ .

4. The ribosome makes _____ .

5. The ribosome follows directions from the _____ .

6. The endoplasmic reticulum gives the nucleus a _____ .

7. The name for all the bodies that perform specialized jobs in cells are the _____ .

8. Cellulose in a plant's _____, keeps the cell rigid so plants can grow taller.

9. The cell part responsible for figuring out what goes in or out of a cell is called the _____.

10. What cell part provides usable energy for the cell? _____

11. How does it work? _____

12. **Diffusion** does <u>not</u> require energy to make substances flow from _____ concentrations to _____ concentrations.

13. **Active transport** requires energy to make substances flow from _____ concentrations to _____ concentrations.

14. What are the bubble like structures used for storing wastes, extra food and water within a cell called? _____

15. Which organelle in green plant cells captures solar energy? _____

16. What do they use to capture energy? _____

Thank-you! We hope you had fun!!!

Appendix E - Consent Forms For Internal Review Board (IRB) - 1

Letter Requesting Consent For Students to Participate in Investigative Project
Project: CellSong Investigators: Karl Kimmel, Teresa Kimmel

Dear Superintendent, Principal or Teacher, [Parental forms were somewhat simplified]

We are seeking your approval to approach teachers of 5th and 6th grade science within your school system to conduct field research.

The purpose of this research project is to test the effect of using a song coupled with animation (i.e., music video) to help students remember scientific concepts and technical terms. Research has demonstrated that when a student listens to a song, the lyrics are remembered better than when the same information is presented in normal speech. *CellSong* is a software program designed to teach students a song about cells. The information contained in the lyrics are in complete accordance with the 7th grade life science learning objectives determined by the State of Virginia. Software packages currently used by schools frequently do not make any use of songs to lock in learning. It is hoped that this project will help determine the effectiveness of using a song (as opposed to plain speech) coupled with a computer-aided instructional program on student recall.

We will follow these procedures: The *CellSong* will be introduced by the subject's instructor and a computer will present the instruction. After the first viewing, the program will be played four more times for reinforcement. Subjects will be asked to attempt to sing the lyrics. After concluding the presentation, the students will be asked to fill out an attitude evaluative form and take a short test. One week later, subjects will be tested for recall. The first session should take no more than 40 minutes. The evaluation session should take approximately 15 minutes.

In reference to extent of anonymity and confidentiality, subjects will be asked to include their names on their responses so as to track which types of students show the greatest improvement and interest in this type of instruction. Their names will not be included in any publishing or presentations. Participants will be granted confidentiality beyond the individuals directly involved in the data gathering. The investigators will not release an individual's test score to any individual who is not working on the project without written parental consent. The names of the teachers, schools, and school district will also not be mentioned in any publication or presentation unless the teachers, school, and school district wish to publicize the experimental findings and their involvement with these experimental technology education developments. If it is desired, the investigators will do what they can to assist both the school and the media.

In some situations, it may be necessary for an investigator to break confidentiality. If child abuse is known or strongly suspected, investigators are required by law to notify the appropriate authorities. If a subject is believed to be a threat to herself/himself or others, the investigator also must notify the appropriate authorities.

There should be no risks for anyone involved with this experiment No compensation is to be earned by subjects participating. The probable benefits of this program for students participating in this program include a better understanding, familiarity and recall of scientific concepts relating to cell's organelles and cellular functions. The larger societal benefits for conducting the research include improved understanding of information recall and improved design methods for Computer Based Instruction, based on this understanding

This research project has been submitted for approval, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department of Teaching and Learning.

Subjects will read and understand the Informed Consent and conditions of this project. Throughout the research, subjects will be reminded by the investigators that the evaluation instrument (test) is of the program's ability to help them learn, not a reflection of their individual ability. Once they have had all their questions answered, they may acknowledge the above and give their voluntary consent for participation in this project.

Subject's voluntarily agree to participate in this study and are responsible to be honest and helpful in responses. They must agree to abide by the rules of this project. If subjects participate, they may withdraw at any time without penalty. They are free not to answer any questions or respond to experimental situations that they choose without penalty.

I agree to allow these investigators to approach teachers of 5th and 6th grade science within this school system to conduct field research.

_____ _____

Signature Date

Should I have any questions about this research or its conduct. I may contact:

_____	EduDesign@aol.com	(540) 962-5979
Karl Kimmel, Investigator	E-mail	Phone
_____	EduDesign@aol.com	(540) 962-5979
Teresa Kimmel, Investigator	E-mail	Phone
_____	gholmes@vt.edu	(540) 231-5587
Glen Holmes, Faculty Advisor	E-mail	Phone
_____	hurd@vt.edu	(540) 231-5281
Tom Hurd, IRB Research Division Chair	E-mail	Phone

Appendix F - Interviews - Gifted Students Program Director and Teachers - 1

Evaluators: Karl (K) and Teresa (T) Kimmel

With Program Director (C), Tuesday, March 3 1998, 11:00

[Re: The instructions for the student post-test (aided recall) stated that the purpose of the test was to test the program not the students.]

C: You want to make sure you really emphasize. I would darken it and I would underline it. Because that probably is the most important thing. To let them know that they are here to help you and not to get a grade on this. And we'll emphasize it too, I mean, I'll tell them that.

[About the first four questions of the students' attitude questionnaire]

C: This is good. I'd put this at the end. (T: Okay) First of all, you want to tell them what it's about and then you want to immediately go to the questions, and then you want to ask them their overall view. And that will be fine. Yeah, they should know most of this

[Referring to the content of the posttest]

C: Looking at test again. Yeah, this is good (referring to the test layout) What I would do is leave all the same size blanks whether it had four or five words or not. I'd make everything the same size. This cell song recall test is very "pin-pointy," so this would be very interesting to see. It's not very broad, it's very right to the point. And this is the one that just does the video game without the music?

K: The literature suggests that the biggest gains will be seen in the Special Ed or the below average

C: Right, and that's what you are going to get, trust me. You are going to get very few gifted in this class. My gifted are all spread out. We have about 140 all together.

[Referring to an article that speaks on how math and science scores are down]

C: Is it that we aren't challenging them or is it that we are not teaching them in a way that these kids can really learn it. You say the way you and I learned is the way we were

taught. But these kids you see are in a new modern world compared to the way I was raised. We didn't have TV every minute. So now they have computers. They have TV They have movies. They have so much freedom than what we ever had. The classroom teachers are competing. They have a lot of information which the kids have no desire to learn. They want you to "spoonfeed" it to them. So how can you activate them to learn? Well I think music is one way. You have to be an entertainer today.

Life Science (S) and Music Teachers (M). Thursday, March 5, 1998 10:00

[About educational uses of songs in the classroom]

M: We use them all the time. As a matter of fact, the 6th graders now are learning the presidents, to have all the presidents in order.

S: What I've done with 7th grade, they write, they write this, they don't put the music to it, but they're supposed to come up with a known melody and their function. That's an assignment I use to get them to learn cell functions, cell part functions. And this is done.

S: I know that's the way I passed chemistry when I was in the 11th grade, we had to have all the periodic tables a little melody..

K: It's kind of like everybody knows that a song helps you remember things but actually advertising research-

S: Yeah advertising people, they use it they use jingles and all that…

C: Karl, what about your alphabet and you sing to "Twinkle , Twinkle Little Star"

S: They always say music that you're singing the part cause that, this is probably not something that I would teach in my classroom, but I could easily teach the seventh graders

[Song is playing]

M: I don't think that you. because you're really not covering anything that would be covered in our SOLs except for when they broke into parts.

K: Can you get me a copy the SOLs…

M: Oh sure. In this county we have a music curriculum that goes way past the... let me see if I've got that that's in the MEJ journal...

[About the recall test]

S: Just by listening to this, I can probably answer all of this from listening to that one where as before, I'm pretty sure I couldn't have really told you this part...it's good, the repetition in it's really good I mean definitely.

S: Just by listening to this, I can probably answer all of this from listening to that one where as before, I'm pretty sure I couldn't have really told you this part...it's good, the repetition in it's really good I mean definitely.

[About the computer]

M: That'll work. So we kind of need to get more information before-- Now if you want to do it in chorus then you would need the Mac

S: Yeah I would have to

M: but there again, 57 students around one Mac--

S: sort of how they would learn

M: they could learn now, they could probably sing it back to you now. I mean that's----...Sorry, we're going to walk into a 6th grade classroom and in 5 minutes they're going to be able to say, "endoplasmic reticulum"

S: That is--Oh I thought you were talking about 7th grade. We're going to have to go back to 6th if they want to get to it this year

M: No, they're not familiar with this work, but the rhythm you're talking about the rhythm

M: Yeah, the and melody, I mean that's very easy to catch on. You know, and we see our kids, I see our kids every single day and then of course every single day here for a year. Well all the upper level kids would catch it, and obviously they're not all upper level, so if you had it right in front of them, it wouldn't take them long at

all. We did something yesterday, a Jamaican carol that they split into 3 parts the very first time we ran through it, and it did the same thing. It sang melody line Section A. Section B. Section C. and they did they did fine. They have good skills in this...music from kindergarten on up. So…

K: Would it be better to put the music on notation or is it better to drop the notation and…

M: No, they would have to learn the reading, notation. I would keep that on there. I won't give them anything without…I don't give them words...not like that at all, we want musicians, we don't want singers, you know, so they learn--...They learn to read music notation. I would never ever think of giving them the words to something without...I wouldn't do it. ...to be.. when they should read music

K: They'll have it

M: The upper level kids would, they'd get it in a snap, it's right in the middle of a range where they could sing, there's no big jumps there's nothing, I mean there's nothing singing wise that's difficult about that...that's good, that's good though, if you're targeting ... kids. If you're using the melody to teach science, if you make both of them too challenging, you're going to shut off 3/4 of the kids. Yeah, so its very very easy .So by making it approachable from at least one aspect like if they like chorus a lot more than they like science then, like she said, they're going to learn the melody they're going to learn the rhythm and the words are going to come, and then that rhythm will be stuck in

S: I think from a science point of view, they're going to need more than one.

M: Right, if they're already familiar with those words, it's going to be very easy for them

S: I can't remember the first time they do cells. There is cells somewhere--

K: Fifth grade

S: Yeah, but I think they do like nucleus, ...

K: Thank you all

S: Oh you're welcome, I think it's great

With mTeacher Friday, 5/15, 11:45-12:30

K: How long did you spend preparing the class for the program?

mTeacher: The last half of class. Probably about 45 minutes.

K: The next class you ran the program.

mTeacher: Right. The other thing I had prepared them for [besides the biological content] was the format. I told them they would see some things right at the beginning (of the program) that don't seem to make sense. "Why would they be seeing music?" I told them that is the whole point of the thing. I reviewed the parts of the cell just in the sense of a simple drawing. Here's what it is, here's what it does. I prepared them a little bit for the format of what they were going to see. "When you first see the musical notes, some of you can already read music so you'll know what they're doing." I prepared the rest of them by going over the musical symbols and what the mean. A total of probably an hour for background. That's both parts, 45 minutes for the cell and 15 for the music.

T: How was the program presented?

mTeacher: We have a class every other day. The program was delivered at the beginning of two class periods [10:30 A. M.], two days apart. We kind of enjoyed it. Actually, it is fun; picking a line and trying to sing it. It is kind of enjoyable. During the course of this, we did a couple of other cell activities. We have a couple of different life science books. What I like to do is have them go and find things we didn't cover (so they can see how different books cover things in different ways). That's about it, I didn't spend a lot of time on it. It is kind of a minor SOL for the fifth grade. I liked it, I guess it's okay to do what we did but I sometimes wonder if it shouldn't just be postponed until the seventh grade and covered more in-depth: genetics and that sort of thing. It's probably a good idea to

give them a taste. That way, when you get to the seventh grade, they at least have some background to go on. [Short discussion on spiral curriculum]

I have the same class from third until seventh grade. My field of study was reproduction. I worked in it for seven years in research. I worked in pure research, I worked with sheep.

K: So we should come back Tuesday at 11:45

mTeacher: Unless there is some surprise… at this time of year you never know. They never bother to tell the faculty anything and all of a sudden you hear this announcement: " Will everyone please come to the gym for the recycling hour, or the magician, or the play or whatever…" There are things that crop up that you don't know about but as far as I know there isn't anything.

Interview with sTeacher (1:45) (Friday 5/15**)**

[Recorded when the evaluation team picked up the student's attitude surveys. sTeacher was never taped]

sTeacher: mentioned that students who ordinarily do well on tests seemed to not do as well and students who do not do as well on tests, did much better than expected.

Appendix G - One-on-one Subject Sophisticate Evaluation Questionnaire

1. Did the program hold you attention?

(Z) Yeah. (J) Yeah. (F)Yeah. (S) Yes. (L) The "cartoons held my attention."

2.. What did you like about it?

(Z) The "song has a ring to it." It is "catchy." (J) likes the highlighted words better than the highlighted notation. (F) Liked the "beat" and the "pictures." (S) The pictures. (L) It is catchy

3. What did you not like about it?

(Z) The beat stays the same. It could get annoying after a while. (J) It is difficult to understand when the song goes into harmony. (F) Nothing

4. Did you find it confusing? If so what did you find confusing?

(Z) No (J) See above (F) No (L) No - "It explains it well. It's not hard at all."

5. How many time would you like to see the [musical] notation before the teacher takes it away?

(Z) 2 or 3 times (J) 5 times (S) 3 times

Additional Comments

(J) Likes music version of program better than spoken version.

(K) Stated he would like to see spoken version of program before musical version. Spoken version was easier to understand but would be harder to remember.

(S) The spoken version is clearer. The music distracts. "S" would like to see more 3d stuff in the background.

Appendix H - Teacher's Program Evaluation Questionnaire - 1

5/7/98 – Field Test Thursday, May 14th

Implementation

1. How do you feel your students will react to this type of presentation?

mTeacher: Kids like songs and visuals- I'd guess pretty well.
sTeacher: The reaction will be mixed, some positive some negative. Sixth and seventh graders are peer influenced. If the right students like it then it will be useful.

2. Do you feel that this program will increase student performance (musical canons or cellular biology)?

mTeacher: I wouldn't use it if I didn't feel it would help.
sTeacher: I don't have any music background so I don't know if it will be helpful in teaching music parts, but I think it will be helpful for students with positive attitudes in remembering biological terms.

3. Would you use this program in your instruction?

mTeacher: I am.
sTeacher: I would try it with first semester grade 6, but not near the end of the year.

3b. Why or why not?

mTeacher:) Second semester 6th graders (significant numbers) become surly, negative, rebellious and skeptical of both new and routine.

4. How would you present this program to your students?

mTeacher: I would present this program within a larger unit, following a brief introduction, but early on to help the student become familiar with the terms and concepts before jumping into projects.
sTeacher: As reinforcement after the unit is presented.

4a. How many times would you make each selection?

sTeacher: 2 or 3

4b. Would you present this program alone or within a larger unit?

sTeacher: As part of a cell unit. Generally, looking over the recall, it won't work as a stand alone. Our students generally take lots of drill and practice. By spending many hours of directed instruction we get a high per cent passage of WPT, but it isn't easy.

4c. What prerequisite knowledge would the student require to maximize the effectiveness of this program?

sTeacher: They should be able to pass (70%) of a multiple choice quiz on cell parts.

5. How might the students use this without help (for the planned recall experiment)?

mTeacher: Hands on. Many of the students are as good with or better at computers then I am and wouldn't have any trouble running this program by themselves.
sTeacher: I don't think it will work as a stand alone.

Content

6. What are the greatest weaknesses (and strengths) of the program?

mTeacher: Weaknesses - Some of the more sophisticated adjustments the computers must make to run programs. Strengths - Stimulates several senses at once songs, visuals both the animation and the bouncing ball with bouncing ball
sTeacher: See #5

6b. How would you want to see them changed?

sTeacher: Well, I'm not saying it should be changed but it has to be teacher directed as part of a larger unit and a teacher with some basic music talent and background would help.

7. Is there any superfluous information given that might hinder students from learning the core content?

mTeacher: I think more students in my classes would have to be directed to an understanding of the music metaphor than the developers would hope would arrive there intuitively.
sTeacher: Nothing I've seen yet.

8. Is the content reasonably complete?

mTeacher: I still teach the idea of phagocytic and pinocytic vacuoles to 7th graders. On the other hand, ATP may be too much into biochemistry.
sTeacher: For it's purpose yes

Interface

9. Are the navigational and help buttons useful and intuitive?

mTeacher: Students generally find computers more intuitive than older teachers.
sTeacher: Fairly, The only problem I've had are glitches he'll the designer work out later

Facilities

10. Does your school have an adequate computer and monitor or LCD display for this type of presentation?

mTeacher: I think by next year most classrooms will have wall mounted, larger screen monitors. This year we don't.
sTeacher: yes

Suggested Cost

11. What do you think a program such as this should cost?

mTeacher: $20 - 30
sTeacher: $20 - 30

Appendix I - Student's Program Evaluation Questionnaire - 1

Please answer the following questions to help us understand what you thought about the program. Your answers will help us improve *Cell's Organelles* and future programs we will be developing. Rate your responses by darkening a box on the scale from 1 to 4. A "1" means that you do not agree at all, a "4" means you agree completely.

1. I knew about all the cell parts and processes in the song before I learned the song.

Disagree **Agree**

---------- | 1 | 2 | 3 | 4 |

2. The song helped me remember the cell parts and processes.

---------- | 1 | 2 | 3 | 4 |

3. The animation helped me remember the cell parts and processes.

---------- | 1 | 2 | 3 | 4 |

4. I knew I was going to learn a song about cells.

---------- | 1 | 2 | 3 | 4 |

5. After hearing the song, I wanted to learn it.

---------- | 1 | 2 | 3 | 4 |

6. I liked the song.

---------- | 1 | 2 | 3 | 4 |

7. I liked the harmony.

---------- | 1 | 2 | 3 | 4 |

8.. I liked the beat.

---------- | 1 | 2 | 3 | 4 |

9. I liked the animation (cartoon) .

---------- | 1 | 2 | 3 | 4 |

10. I liked the characters in the animation (mitochondria, ribosome, etc.).

---------- | 1 | 2 | 3 | 4 |

11. What was your favorite part of the animation? Why?

_____

12. The program held my attention.

---------- | 1 | 2 | 3 | 4 |

13. Teachers in our school sometimes use songs or raps to help us remember. (For example, songs that are about how a bill becomes a law; the fifty states and their capitals; the thirteen colonies; multiplication tables; or raps about grammar, chemistry, history…)

Disagree **Agree**

---------- 1 2 3 4

14. Teachers in our school sometimes ask us to write raps or songs about things we learn in class.

---------- 1 2 3 4

15. I like it when my teachers use songs to help me remember.

---------- 1 2 3 4

16. I like learning songs better than other ways teachers use to help us remember things (worksheets, computer practice, studying textbooks)

---------- 1 2 3 4

17. I like it when my teachers use songs to help me remember but only when I like the style of music.

---------- 1 2 3 4

18. I think learning this song will help me do better on a test about the parts of a cell.

---------- 1 2 3 4

19. Generally, I found this program an interesting and entertaining way to help remember scientific concepts and processes

---------- 1 2 3 4

20. The ways I most like to practice the things I have to remember are…

_____

21. I liked singing along with the program.

---------- 1 2 3 4

22. The song presented enough information

---------- 1 2 3 4

23. The song presented too much information.

---------- 1 2 3 4

24. Are you studying a musical instrument? (If so, which one and for how many years?)

_____

25. Would you like a part written for your instrument so that you could play along with class when they sang the song?

Disagree **Agree**

---------- 1 2 3 4

26 Do you sing in a chorus or choir? (If so, how often and for how many years?)

_____

26. Do you study music in school? (If so, how many days a week?)

_____

28. I tried hard to sing the song well.

---------- 1 2 3 4

29. I tried hard to learn the words so I could sing them better.

---------- 1 2 3 4

30. I tried hard to learn the words so I could pass a test about organelles.

---------- 1 2 3 4

31. The class started to sound pretty good after a while.

---------- 1 2 3 4

32. We need to practice the song more before it will sound okay.

---------- 1 2 3 4

33. It was hard to hold my part when the song went into three parts even after practicing it five times.

---------- 1 2 3 4

34. Now, I think that I can hold my part even if no one else is singing it with me

---------- 1 2 3 4

35. I would like to try to sing this song in smaller groups

---------- 1 2 3 4

Disagree **Agree**

36. I feel that I really understand the material covered.

---------- | 1 | 2 | 3 | 4 |

If so, why do you think it works?

_____

37. I feel I will remember this material longer then if I had read it in a text book or heard it in a lecture.

---------- | 1 | 2 | 3 | 4 |

38. I could have run the program for the class while the teacher prepared another activity.

---------- | 1 | 2 | 3 | 4 |

Please respond with a brief essay:

39. How is a cell like music?

_____
_____
_____

40. What do you think will improve the program most?

_____
_____
_____

41. Please sketch a plant cell and label all the parts you can remember.

Thank you for all your help.

Appendix J - Student's Questionnaire - (Items Divided by Classes)

Prior Knowledge

1. I knew about all the cell parts and processes in the song before I learned the song.

Novelty

4. I knew I was going to learn a song about cells.

13. Teachers in our school sometimes use songs or raps to help us remember. (For example, songs that are about how a bill becomes a law; the fifty states and their capitals; the thirteen colonies; multiplication tables; or raps about grammar, chemistry, history…)

14. Teachers in our school sometimes ask us to write raps or songs about things we learn in class.

How students enjoyed learning using this method

2. The song helped me remember the cell parts and processes.

3. The animation helped me remember the cell parts and processes.

15. I like it when my teachers use songs to help me remember.

16. I like learning songs better than other ways teachers use to help us remember things (worksheets, computer practice, studying textbooks)

17. I like it when my teachers use songs to help me remember but only when I like the style of music.

How Students liked the song

5. After hearing the song, I wanted to learn it.

6 . I liked the song.

7. I liked the harmony.

8. I liked the beat.

How Students liked the Animation

9. I liked the animation (cartoon).

10. I liked the characters in the animation (mitochondria, ribosome, etc.).

11. (Short answer) What was your favorite part of the animation? Why?

How Students liked the Program

12. The program held my attention.

19. Generally, I found this program an interesting and entertaining way to help remember scientific concepts and processes

21. I liked singing along with the program.

22. The song presented enough information

23. The song presented too much information.

40. (Short Essay) What do you think will improve the program most?

Student Perception of Program's Success in Class

31. The class started to sound pretty good after a while.

32. We need to practice the song more before it will sound okay

38. I could have run the program for the class while the teacher prepared another activity

Metacognition -(How I learn music best)

33. It was hard to hold my part when the song went into three parts even after practicing it five times.

34. Now, I think that I can hold my part even if no one else is singing it with me1

35. I would like to try to sing this song in smaller groups

Student Focus

28. I tried hard to sing the song well.

29. I tried hard to learn the words so I could sing them better.

30. I tried hard to learn the words so I could pass a test about organelles.

Metacognition -(How I recall best)

18. I think learning this song will help me do better on a test about the parts of a cell.

20. (Short answer) The ways I most like to practice the things I have to remember are…

36. I feel that I really understand the material covered. (Short essay)-→If so, why do you think it works?

37. I feel I will remember this material longer then if I had read it in a text book or heard it in a lecture.

Prior musical experience

24. (Short answer) Are you studying a musical instrument? (If so, which one and for how many years?)

25. Would you like a part written for your instrument so that you could play along with class when they sang the song?

26. (Short answer) Do you sing in a chorus or choir? (If so, how often and for how many years?)

27. (Short answer) Do you study music in school? (If so, how many days a week?)

Student Performance Items

39. (Short essay) How is a cell like music?

Appendix K - Student Evaluation - Short Answers - 1

11. What was your favorite part of the animation?

Location S

K. - "Was when the cells played the instruments because they looked cool

M. - "When they [the organelles] were going to work because they looked funny."

D. - "There was no favorite part."

A. - "Where the blue cells and the others went into where he talks with other cells."
[Where the nucleus communicated with the ribosomes via the endoplasmic reticulum.]

S. - "I didn't have a favorite because they all look the same because they are round."

B. - "The little cells moving all around the screen." [?]

C. - "Where the question marks came up. I like the '?' marks"

J. - "Just characters."

M2. - "Showing the cell. It helps you learn better."

H. - "The working cells part where the little people had the lunch pails it was cute."

St. - "I don't have one because they are all okay."

Location M

S. - "I liked that."

A. - "The characters, they acted out what they do."

R. - "I liked the part 'Organelles work in Cells' because the pictures were cool."

D. - It showed the parts going to work it helped me understand things about it."

Se. - "At the beginning because I liked the beat of the music practice."

Da. - "I Liked the part where the cells were going into a factory because it was just like a real cell in my opinion."

J. - "When it showed you how to play a bass, it showed me a few things."

L. - "Organelles working in cells because the pictures."

T. - "The part when they are playing their instruments. It's cool."

Jo. - "What goes in and what goes out was my favorite."

M. - " The very first part because I like the beat and the words the guy was singing."

20. The ways I most like to practice the things I have to remember are…

Location S

K. - “To listen to music while I read.” [?]

M. - “Songs.”

L. - “writing them down over and over.” [The student had nice handwriting.]

D. - “reading a book about it.”

A. - “with a song or an outline with the data on it.”

S. - “reading in a text book.”

Am. - “reading them by myself or watching it on TV.”

B. - “listening to them on tape.”

C. - “Study”

J. - “computers or work sheets.”

M. - “learn them in class.”

Ja. - “computers.” [?]

H. - “hands on activities or maybe like this song thing.”

St. - “to listen to a song about cells.”

Location M

S. - “ to write them out neatly on note cards so it’s easy to study.

A. - “by song or rap”

R. - “computer, music.”

D. -“to read them over.”

Se. - “to do them over and over.

D. - “in little groups.”

L. - “Sings”

T. - “write them down some times.”

Jo. - “singing it.”

39. How is a cell like music?

Location S

K. - It works together like music's harmony.

M. - "Cells are like music because music can be put together like cells work together."

D. - "The plant works like music"

A. - "The music explains to use what the cells do. Then the cells do it. It was like the mother telling children what to do."

S. - "It has harmony."

B. - "There are so many parts to a cell. There are so many parts to a song."

C. - "It works together to work in the body."

Ja. - "There are a lot of different parts."

H. - "It has a certain beat."

St. - "A cell make communication and makes harmony."

Location M

R. - "It makes more sense then lectures do."

40. What do you think will improve the program most?

Location S

K. - "I think the program is fine the way it is."

M. - "Nothing really."

L. - No response.

D. - "It will give an idea of how the cells in a plant work.

A. - "Do programs that sing longer. More pictures of cells and the words. Make a book for kids to learn the music and words."

S. - "Making textbooks and getting better beat and singer."

B. - "More people involved."

C. - "Nothing"

J. - No response

Mi. - "Get a new style of music."

Ja. - "Different"

St. - "I think that using a computer with harmony is better than learning it from a teacher. Sometimes you can't understand what they are saying."

Location M

R. - "Nothing. It's great already.

"I think nothing will because it is already as good as it could get."

41. Student's drawing and labeling of the plant cell (described by evaluator)

Location S

K. - Picture with three organelles properly labeled

M. - Picture unlabelled, parts unclear.

L. - Picture with three organelles properly labeled

D. - Labeled picture of plant, not a plant cell.

A. - Drew a labeled picture of plant and an unclear picture of cell

S. - Cell picture clear but unlabeled

B. - Cell picture with six organelles labeled, used another source

C. - Cell picture not very accurate, labeled four organelles, used another source

J. - Picture inaccurate, not labeled.

Mi. - No picture

Ja. - Picture with three organelles labeled.

St. - No picture

Location M

No drawings

Appendix L - National Standard of Learnings For Arts Education

Choral Performing Groups (Grades 7-8)

1. Singing alone and with others, a Varied Repertoire of Music

A. Students sing accurately and with good breath control throughout their singing ranges, alone and in small and large ensembles.

1. Understand the vocal mechanism
2. Develop and use correct sing posture
3. Develop and use correct breathing skills
4. Develop good tone, demonstrating proper breath support, vowel pronunciation, and placement/ focus and head/chest voice
5. Develop proper diction through the correct use of vowel shapes, syllabic stress, consonants, and diphthongs
6. Develop tonal awareness
7. Exercise responsible use and care of the voice

C. The student will sing music representing diverse genres and cultures with expression appropriate for work being performed including….pop...

E. Students sing music written in two and three parts (etc.)

D. Sing with accuracy a varied repertoire of vocal literature with a difficulty level of 3 (etc.)

2. Performing on instruments, …skill on a musical instrument, particularly a keyboard, is a definite asset for a singer/chorister and such skill should be encouraged at every opportunity
3. Reading music (all)

6. Listening to, analyzing and describing -

Esp C. Students demonstrate knowledge of the basic principles of meter, rhythm, tonality, intervals, chords, and harmonic progressions in their analysis of music.

1. The student will discuss musical elements, including meter and rhythm, present in a recording of choral music.
2. (Harmonic progressions - I, IV, ii, V progression used in CellSong)

8. Understanding relationships between music …and disciplines outside the arts

B. The students will apply information learned in music to science classes.

Karl Kimmel - Vita

Education:

* Ph. D. - Instructional Systems Development Program, Virginia Tech, 98
* Master's Degree - Curriculum and Instruction, Virginia Tech, 95
* Graduate Courses toward Teaching Certification - Mary Baldwin University, Teaching Methods and Horticulture, 91; Dabney Lancaster Community College, Child Psychology, 91. Radford University, Helping Children Cope with Crisis, 88; Florida Atlantic University, History of Education and Educational Evaluation, 85
* Bachelor's Degree - Biology, Herbert H. Lehman College (CUNY); Regents Scholarship, Dean's List, 76
* National Teacher Examination Scores: 98% General Knowledge: 95% Biology and General Science: 91

Educational Projects:

* Designed, created and evaluated the "CellSong" computer program (Windows); Integrates music and animation to help facilitate middle school students' recall of concepts and facts dealing with cellular physiology, 97 - 98
* Designed and created "AerobicKeys" computer program (Macintosh); presents accompanying music, monitors and records student piano keyboard performance and gives instantaneous feedback to students; Accompanies piano method developed by Dr. M. Shender and M. Kimmel (Mercy/Bronx House/Columbia University), (Ongoing)
* EERA, Presentation, "Melodic and Lyrical Facilitation of Recall," 2/97
* Music Mnemonic presentation, Hopkins Planetarium, Science Museum of Western Virginia; For Virginia biology educators, 92
* First place in "Take Pride in America Program" and special award from the "National Education Development Project" with D. Hodges; helped middle school students compose and record "raps" dealing with alternative energy sources, 91

Publications:

* "Religious Technology" (in publication) Explains how liturgical prayer may facilitate a more efficient long-term memory search
* "What are the qualities of a good or bad coach as perceived by serious young, rural athletes?" (in publication) Qualitative study

Music Education:

Bass - (Acoustic and Electric) Richard Davis, Edward Lord, June Rotenburg, Clyde Lombardi; *Arranging* - Joseph Kennedy, Martin Holmes; *Keyboards* - Dr. Kent Holliday; *Voice* - Lisanne Lyons, Greg Frelino; *Guitar* - Sal Salvadore

Employment:

* Kim-West Music, Inc. (91 - present); Tuxedo Junction (84-91)
  Positions: Band leader, Bassist, Vocalist, Arranger; Responsibilities: Oversee musical needs of The Homestead Hotel: hire and train musical personnel, direct rehearsals, select and purchase equipment, setup stage and sound equipment, compose vocal and instrumental arrangements in a variety of musical styles

* Bath County Department of Education, Alleghany County Dept. of Ed., City of Covington Dept. of Ed.; Position: Substitute teacher; science, math, music; 91-92
* Arsoa Advertising Campaign, Position: Location director for Virginia sequence - "The Natural One" 92

Personal:

Born 12/8/55, Married, three children