

# Interactive Multimedia for Teaching Nematology<sup>1</sup>

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*Abstract:* The availability of interactive multimedia authoring software programs promises to revolutionize the teaching of nematology. These programs integrate text, hypertext, graphics, animations, video, and sound. The user interacts with the information on demand in a nonlinear fashion. Beginning students can limit themselves to the general outlines of the subject, and advanced students can explore the information to the limits of their ability. Use of interactive multimedia does not eliminate the need for effective, enthusiastic teachers but provides a mechanism for the efficient transfer of information. An interactive multimedia presentation that supplements lectures in an introductory course is presented as an example of the application of this technology for teaching nematology.

*Key words:* authoring program, computer, instruction, multimedia, nematology, teaching.

A revolution in education has occurred in the last few years based on the widespread availability of interactive multimedia authoring software—programs that integrate text, hypertext, graphics, animations, video, and sound. With a multimedia encyclopedia, for example, one can look up “Franklin D. Roosevelt,” find his picture and associated biographical text, select the word “speeches” to find a transcript of his “day that will live in infamy” address to Congress, and then click a button and watch and listen to a video of President Roosevelt giving the speech.

Envision an interactive multimedia program on nematology and imagine looking up “biological control” and seeing a chart of the most important instances of biological control in nematology and a brief explanatory text. Select the subtitle “Fungi” and see an animation of a parasitic fungus attacking a plant-parasitic nematode. After the video is finished, a list of nematode species is presented. Choose “Heterodera” and a list of parasitic fungi is revealed. Pick “Catenaria” and color pictures of the fungus and nematode are shown, specific text is displayed about techniques for utilizing this particular parasite as a biological control agent, and a video of the fungus parasitizing the nematode is shown.

## LEARNING THEORY

The human mind has the remarkable ability to assemble small pieces of information, ideas, and experience into intricate webs that form larger assemblages of information, eventually leading to the comprehension of theories and principles. Information in the biological sciences is rapidly increasing in volume and changing in content. This incredible growth in biological knowledge often results in less attention to rote memorization and more emphasis on problem solving and the development of reasoning skills. An essential role of the teacher is to show the student how to cope with the mass of scientific knowledge and to teach the theories and principles that link all of the information into reasonable and manageable outlines (1,2,4,5). This assimilation of theories and principles is facilitated by interaction of the student with the subject matter, rather than by the accumulation of a large mass of information.

Seeing, doing, and thinking are the three stages of learning. With multimedia, the students do not just sit back and watch but instead interact with a computer to acquire information on demand in a nonlinear fashion. Information that is unimportant or previously learned does not block the path to information that is important which can be accessed immediately. Assimilation of information into the final and most sophisticated stage of learning occurs from the integration of the symbolic world of language and mathematics into the vi-

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sual and interactive world. Interaction with information results in the development of thinking. The facilities needed to build these capabilities into programs on personal computers are now readily available.

#### IMPORTANCE OF TEACHING NEMATOLOGY

Nematology is an important subject in courses in plant pathology, invertebrate zoology, soil biology, soil science, animal parasitology, botany, ecology, genetics, molecular biology, entomology, developmental biology, horticulture, crop science, and others. Because these courses are largely taught by few professionals educated as nematologists, resources for teaching nematology are relatively limited, textbooks are few, and there is no advanced textbook on the subject. As a result of inadequate resources, this extremely important group of organisms does not receive the attention in related disciplines that it deserves. Students specializing in plant nematology frequently gain their first formal exposure in graduate courses.

Nematology, like many other areas of science, is making rapid advancements in some fields. Each year more and more information is assimilated by teachers, but the time devoted to teaching nematology remains constant or is reduced. Therefore, more information must be presented in a shorter period of time. The challenge for the teacher is to teach more effectively, covering more information in less time with greater potential of assimilation and retention. Much information obtained from the traditional class taught with lectures is learned by memorizing handouts or by reading assigned material. Traditional lectures, although they are inefficient tools for conveying information, are very effective and essential for conveying enthusiasm and excitement about the subject (7). Enthusiasm is important for motivating students to learn about the subject matter. One way to elevate interest in the subject matter is by facilitating the interac-

tion between the student and the information.

#### INTERACTIVE MULTIMEDIA

Interactive multimedia presentations are relatively new and have not been utilized to present information on plant nematology; however, the utility of interactive multimedia for training and education has been effectively demonstrated (1,8). The United States Army clearly showed the value of interactive multimedia more than 14 years ago when it developed a tank simulator. The Army found that the training was just as effective as the actual experience (5). More than 90 percent of the men that were trained with the simulator said that they would prefer that their next training course utilize interactive technology.

Use of interactive multimedia is expected to undergo a five-fold increase by 1995 (5). Although the technology has been developed, educational packages that utilize it are just now under development. Interactive multimedia will greatly impact future teaching techniques. This technology shortens the time necessary for training, is superior for managing files and databases, and is more effective in presenting data in a more understandable way than text-based instructional systems. Benefits associated with interactive multimedia include equal or greater effectiveness than other methods, a 50% reduction in training time, higher learning gains, nearly a 30% increase in retention, 100% consistency of presentation, a 24-hour accessibility, and ease of distribution (5).

This innovation in learning promises a quantum leap in education, transforming students from passive recipients of information to active participants. Because the visualization of phenomena allows an interaction between the student and the information, multimedia technology is very efficient for transferring information and is thus extremely valuable for teaching.

This technique enables students to learn much information in a short period of time and minimizes the drudgery of rote memorization. As a result, learning is often made into a more enjoyable experience.

Interactive multimedia presentations allow students to control the pace, stopping where and whenever necessary. Material can be reviewed as many times as needed for a complete understanding of the subject matter. Interactive multimedia presentations allow the student to select the appropriate level of detail based on their personal level of understanding. Beginning students can limit themselves to the general outlines of the subject, whereas advanced students can explore to the limits of their ability.

The flexibility of the computer allows

for continual update and change in format to make each lecture as complete and timely as possible. The incorporation of new data into a lecture is as simple as importing additional resources into appropriate places, whereas printed texts are notoriously out of date. New editions of textbooks are difficult to prepare and costly to print, but electronic books are easy to change and the costs of production are moderate.

Currently available authoring programs allow educators to write computer programs that merge a wide variety of media into interactive teaching presentations. These authoring programs are easy to learn and use and incorporate multimedia into lessons that supplement or replace the traditional lecture. The interaction with information and the visualization of phe-

**A**

**Introduction to Nematology Lectures**

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**B**

**Lecture 1**

Introduction - The Phylum Nematoda

*"Where their worm dieth not and the fire is not quenched." Mark 9:44.*

- I Introduction to nematodes
  - \* A. Diversity of habitat
    1. marine
    - \* 2. animal parasites
      - \* a. free-living
      - \* b. plant-parasitic
    3. soil and freshwater
  - B. Similarity of form
    1. size - usually microscopic (0.5-3.0 mm in length)
    2. shape - generally fusiform; may be filiform or pyriform
    3. bilateral symmetry
    4. triradiate esophagus
    5. nonsegmented

1 Contents

**C**

**Lecture 1**

**Reading Assignment:**

Chitwood, B. G. and M. B. Chitwood. (revised). 1974. An introduction to nematology. University Park Press, Baltimore. Chapter 1.

**Supplemental Reading:**

Cobb, N. A. 1915. Nematodes and their relationships. Yearbook of Department of Agriculture for 1914. Government Printing Office, Washington, D.C. pp. 457-490.

Mai, W. F. 1985. Plant-parasitic nematodes: their threat to agriculture, pp. 11-17. In *An Advanced Treatise on Meloidogyne*, Vol. 1. Sasser, J. N. and C. G. Carter (eds.). NCSU and USAID, Raleigh, NC.

Thorne, G. 1961. Principles of nematology. McGraw-Hill Book Co., New York. 663 p. Chapter 1.

Print it Read it Contents

**D**

**Lecture 1**

Close Questions	Close Notes
<ol style="list-style-type: none"> <li>1. Compare and contrast fusiform, filiform, and pyriform.</li> <li>2. What are the advantages and disadvantages of a worm-like body shape versus a swollen body shape?</li> <li>3. Compare and contrast bilateral symmetry with triradiate symmetry in nematodes.</li> <li>4. What percentage of nematodes live in the sea?</li> </ol>	<p>Marine nematodes are the most common.</p> <p>The teacher is very good and the subject matter is very interesting.</p> <p>Answers to questions:</p> <ol style="list-style-type: none"> <li>1. Filiform is shaped like a thread, fusiform is tapered on both ends, and pyriform is saecate.</li> <li>2. Worm-like bodies are motile but saecate forms are immobile, but have increased permeability.</li> </ol>

Contents

FIG. 1. Examples of materials from a computer interactive multimedia teaching program for introductory nematology. A) Lecture cover. The next page in the lecture, which is in the format of a book, is accessed by clicking the arrow in the upper right-hand corner. B) Lecture one, page one. Clicking on the asterisks, text in bold or italics, or other buttons reveals additional information, pictures, graphics, animations, cartoons, voice, or sound. C) Reading assignment for lecture one. This scrollable list of references is revealed by clicking on the button that is marked by the open book and reading glasses. D) Questions from lecture one, page one. Clicking on the button with a hand with a pen reveals an empty field for entering text to answer questions about the information on that page and for typing additional notes and information.

nomena and data are the most important aspects of this innovation in teaching.

#### EXAMPLE

The remainder of this paper consists of one example of interactive multimedia used for teaching an introductory lesson on nematology. Unfortunately, this paper is limited to text and pictures and is linear in nature. Readers will have to use their imaginations to visualize the following brief example of a multimedia presentation.

The lecture notes presented in the class handouts were converted into a multimedia format on a personal computer with an authoring program. Hypercard, version 2.0.1, was used for this example, but many other suitable programs are available. Several authoring programs are currently available for both Macintosh and IBM-compatible computers; some can easily be converted to run on both platforms.

The Hypercard authoring program is analogous to a stack of cards. Each card is a computer screen. Cards contain fields of text and data, pictures, graphics, and buttons that invoke action. Text is typed, imported, or scanned with an optical scanner and character recognition software. Drawings and photographs are digitized and placed in an appropriate format for display within the lecture. Also, grayscale and color images are displayed within the stack. Animations are created and presented, sounds are digitized and utilized, and other data may be presented.

The class handouts from a course (PPWS 5024, Plant Disease Agents II, Department of Plant Pathology, Physiology and Weed Science, Virginia Polytechnic Institute and State University) that was taught in a traditional lecture format were converted into a multimedia presentation. The text was imported into fields within the authoring program in the format of a book (Fig. 1). The book metaphor is user-friendly because students are very familiar with the concept of turning pages in a book backwards and forwards, and with the idea

of organization of topics or lectures into chapters.

The cover of the book shows the title and instructor's name (Fig. 1A). The user "opens" the book by moving the cursor to the arrow in the upper right-hand corner and clicking the mouse. The first page of the lecture displays the lecture number, title, and initial portion of the outline of the lecture (Fig. 1B). Pages are turned by activating the arrow buttons in the upper corners. The return arrow in the lower right-hand corner of the page is used to go directly to the table of contents to access lectures on additional topics. Page one also contains four "buttons" in the lower left-hand corner. The first button sends the user to a nematology bookshelf for other multimedia presentations, which include a pictorial glossary, a taxonomic key, distribution maps of various genera, and other

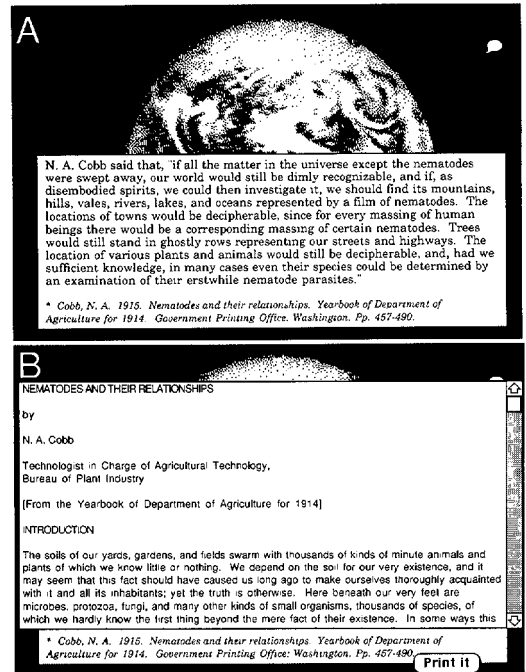


FIG. 2. Cobb's concept of nematodes as related to the universe. A) The earth from space appears when the asterisk is clicked beside the "A" in the text on page one. It contains an additional "Quotes" button that reveals additional information about the picture in relation to nematology. B) The original source of the quote (3). Clicking on the reference of the original source for a quote reveals the entire text of the source and a "Print it" button.

resources. Clicking on the button marked with an open book and reading glasses reveals the reading assignment for lecture one (Fig. 1C). A "Print it" button appears also and allows the student to print a copy of the assignment. The third button discloses a list of all the questions that represents information presented on that particular page (Fig. 1D). Questions for the examinations are selected from lists of all pages. The fourth button reveals an empty text field that is used for answering the questions or taking additional notes (Fig. 1D). The questions and notes are hidden by activating the "Close question" or "Close notes" button(s).

Some of the text of the lecture outline was converted from plain text to "hypermedia." Hypermedia includes images, graphics, sounds, animations, voice, video, or additional text that more clearly illustrates the meaning of the words. It is incorporated into the notes so that the lec-

tures become interactive. Lines of text marked with asterisks are illustrated with pictures or animations that are revealed by clicking on the asterisk (Fig. 1B). When the user clicks on the asterisk beside "A," a picture of the earth from space is displayed. Additional information explaining the picture is revealed by activating the "Quotes" button in the upper right-hand corner (Fig. 2A). The entire original source (3) for the quote is made available if the reference printed in italics is clicked (Fig. 2B). A printout of the article is received by activating the "print it" button. Clicking anywhere else on the screen causes everything to disappear and page one of the lecture to reappear (Fig. 1B). Other asterisks show photographs (Fig. 3) and drawings (Fig. 4A). Boldface words are vocabulary terms that nematologists should know (Fig. 1B). Clicking on a word defines and illustrates it in a pictorial glossary (Fig. 4A). The proper pronunciation of the word can be

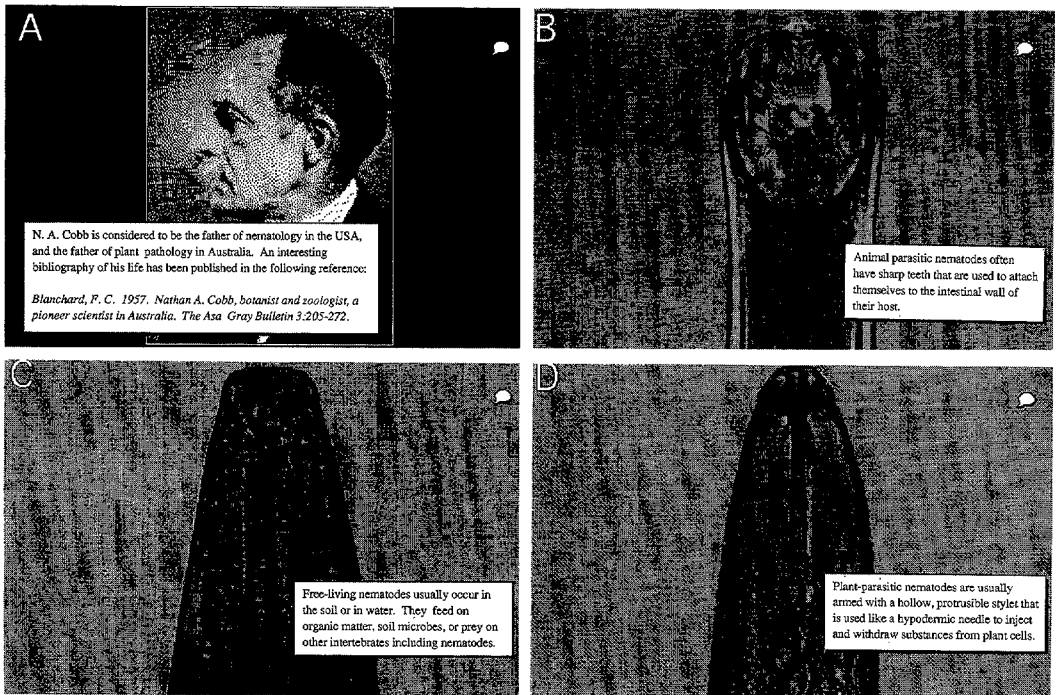


FIG. 3. Introduction to nematodes and their morphology. A) A picture of the father of nematology in the United States appears when the asterisk on page one next to the "T" is clicked. B) Anterior morphology of a typical animal-parasitic nematode, which appears when the asterisk beside the "A.2" is clicked. C) Picture of a free-living nematode, which appears when the asterisk beside the "A.3.a" is clicked. D) Morphology of a plant-parasitic nematode, which appears when the asterisk beside "A.3.b" is clicked.

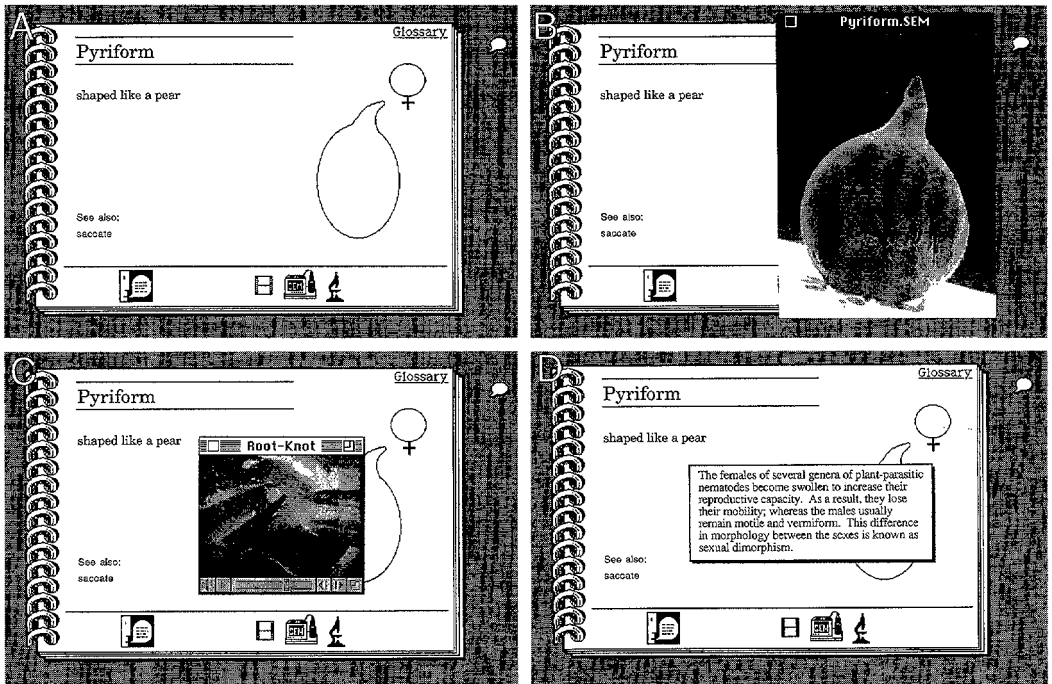


FIG. 4. Examples of additional information that is embedded within the information in the lecture. A) Vocabulary words in bold type are defined and illustrated in a pictorial glossary. Clicking on the bold word "pyriform" on page one of lecture one reveals the definition of the word and a diagrammatic picture. The proper pronunciation of the word is spoken when the "Say it" button in the lower left-hand corner is clicked. B) Scanning electron micrograph illustrating the word "pyriform." The picture appears in grayscale when the button with the SEM is clicked. C) A video of a pyriform nematode being removed from plant tissue is shown when the "Movie" icon is clicked. D) Explanation of the vocabulary word's relationship to nematology. Clicking on the "Quotes" button reveals additional text that explains the word's usage in nematology.

heard by activating the "talk" button in the lower left-hand corner. Also a light or scanning electron micrograph that illustrates the word is revealed by activating the appropriate button (Fig. 4B), and a video of a pyriform nematode being dissected from plant tissue is presented when the "Movie" icon is clicked. Further explanation about the usage of the word in nematology is given by activating the "Quotes" button in the upper right-hand corner (Fig. 4D). Clicking anywhere else on the card returns the user to page one of the lecture (Fig. 1B).

#### CONCLUSIONS

Effective teaching is critical to the survival of nematology. The application of interactive multimedia presentations for teaching nematology promises to revolutionize teaching. Merrill (6) called for in-

novations in teaching plant pathology 15 years ago. He envisioned a collection of short films that would help students visualize various phenomena in plant pathology. In 1978, the technology to perform this task was available but very expensive and time consuming and thus never attempted. Currently, technology is available at modest costs to utilize interactive multimedia for teaching.

Interactive multimedia changes the role of the teacher from being the source of information to that of facilitator; however, the importance of the teacher in the transfer of information remains the same. If the teacher is enthusiastic about the technology, the students likewise become enthusiastic. Therefore, the teacher remains the most important stimulant to learning. Information becomes easily accessible and learning becomes more dependent on the student's interaction with the information.

The challenge of education in nematology is to interface innovative technology to enhance the teaching of nematology. There is an increasing need to better educate students in nematology, plant pathology, and related disciplines. A greater knowledge systemized for teaching will benefit universities and the general public. It is hoped that improved nematological education will facilitate greater awareness of the economic importance of nematodes and thus ensure the health of nematology into the next century.

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