Chapter 10

Computer Enhanced Learning in Biology

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Introduction

Over the last few years, computers have attracted widespread interest as teaching tools in the biological sciences. Parallel to this interest has been the development of computer programs for use within educational systems, much of it targeted at the high school level.

Unfortunately, many of the commercial programs are not well suited for use within computerized learning in the biological sciences. Even though there is courseware available for use at the college level, it may not be that extensive, may be expensive to purchase, especially if multiple copies are required, and may be quickly rendered obsolete by curriculum changes. The content and program quality may be variable and more suited to a global understanding of biological concepts. Furthermore, most courseware does not allow modification for local use. This can be a real problem, if the terminology used in the courseware is different from that used in local courses, or if examples used in the courseware are not local and are unfamiliar to the students. In addition, potential purchasers of such software usually have no option to view the material before purchase. This frequently results in the purchase of a program that is potentially unsuitable for computerized learning within courses or programs.

As a result, many biologists teaching in colleges and universities are attempting to author their own courseware. As courseware authors know only too well, authoring takes much more time than staff have available. Furthermore, most institutions do not give courseware creation the same weight as research and teaching in promotion and tenure decisions. Additionally, there is usually no money available to help potential authors create courseware. Courseware authoring is likely to remain a minor activity at the college level for the foreseeable future. However, as computers become more available to a greater number of students, there will be an ever increasing demand for good college-level courseware.

Computer Enhanced Learning

In addition to the traditional uses (for word processing, databases, spreadsheets, and drawing), computers can offer a number of advantages to the science educator in the form of courseware that offers:

- tutorials (drill and practice — response oriented interaction),
- problem solving (laboratory and lecture exercises),
- simulation exercises (in lecture or laboratory settings),
- enrichment programs,
- remedial learning (continuous and repetitive),
- games (applications of problems or concepts), and
- testing (test banks with evaluation and analysis).

There are also a number of advantages to the use of computers that can actually enhance learning. These include:

- establishing individualized learning situations,
- self-paced learning opportunities,
- immediate feedback to the student and the instructor,
- lack of distractions and increased attention span,
- automatic adjustment to ability levels of students,
- continuous interaction, and
- flexible time scheduling for the students and the instructor.

Computers are also very flexible when it comes to interfacing (connecting and operating) with other types of equipment. For example, computers can be connected (with the appropriate hardware and software) to videotape and videodisc players, slide projectors and cassette players, laboratory equipment (for direct display of equipment readings), video cameras (color and black and white), and digitizing pads and tablets.

Two of the more common applications of computer-based instruction are Computer Managed Instruction (CMI) and Computer Assisted Learning (CAL).

Computer Managed Instruction (CMI)

In courseware developed for computer managed instruction, the computer program manages a student's progress through a unit of work. The program may limit a student's progress until mastery of the assigned material is accomplished by means of testing with a predetermined pass mark. For students who fail an assigned level, the program may switch to remedial lessons to reinforce and strengthen the perceived weaknesses of the student. Most CMI programs will also keep track of students' progress and record scores throughout the learning unit.

Computer Assisted Learning (CAL)

Computer Assisted Learning encompasses a wide range of computer-based activities that can include:

- learning units and tutorials,
- demonstrations,
- simulations,
- educational games,
- dialogues (between the students and the computer), and
- interaction with an electronic textbook.

Computerized testing can also be a part of CAL (Collins, 1987). Within a CAL program, the courseware developer can incorporate:

- opportunities for learning (drill and practice),
- pretesting to determine the student's subject knowledge or ability level,
- testing and scoring of the performance of students in lessons and learning units,
- graphic analysis of student score data,
- features that permit the module to be evaluated by the students, and
- identification of problem areas in the learning module.

The use of computer-based instruction (CBI) has been shown to increase students' achievement scores (Collins, 1984, 1987), improve students' attitudes towards learning, produce substantial savings in instructional time, permit students to decrease the time taken to complete their studies in comparison to students in courses taught by conventional methods (Collins, 1986; Collins and Fletcher, 1987), and reduce the chances of students withdrawing from courses or not writing the final exams (Collins, 1990; Collins and Earle, 1990). Class remediation has been shown to be an interesting use of computer test data (Collins and Fletcher, 1985).

The Selection of Authoring Software

The selection and purchase of authoring software for use by individual instructors for courseware development is not an easy task. Collins (1989b, 1991a, 1991b) suggests a number of areas that should be addressed before final selection of authoring software.

Can the software run on your computer system and/or on the systems used in your computer lab?

Many educational institutions have computers that range from Apple computers, to IBM compatibles to main frame computers. Very often, the computer that an instructor will use for daily computing or courseware development will not be the same type of computer that will be used by students. Personal computers and those used by staff tend to become obsolete at a faster rate than institutionally-owned computers. For example, a number of our faculty use IBM-compatible PC/XT desk computers with monochrome monitors, while our students have access to a computer lab with IBM-compatible 386 microchip computers with VGA (Visual Graphics Array) cards for use with monochrome and color monitors.

Do you intend to run the instructional software in computer labs that use different operating systems (e.g., Apple and IBM computers)?

If this is the case, then you may have to purchase different versions of the chosen authoring software to run under the different operating systems of the computers. In addition, the command sequences and programming statements of the software may be different for each operating system used. This will require the user to be knowledgeable in the different versions of the software used on different machines.

How much computer memory (RAM – Random Access Memory) will the program require to run and still leave memory available for the user?

Unlike the older IBM-PC/XT computers, which were limited to 640K RAM, the newer computers (386 and 486 microchip machines) have access to much more RAM, if it is available on the system. The amount of RAM available on your system may limit the authoring program that can be used. You may find that you will have to purchase additional RAM for your computer to accommodate the advanced features of the software. The trend today is for computer software to require access to more RAM (for faster processing) and to use more hard disk space for the storage of program and user-produced files.

What type of computer drives will the software require (360K or 1.2 MB, 5.25" disk drives; 720K or 1.44 MB, 3.5" disk drives; a hard disk [hard drive])?

Most computers today will support either of the above disk drive formats. But, you may find yourself writing and producing software for older IBM-PC/XT machines simply because these are the only machines available to your students. If this is the case, then you may be forced to develop programs of limited size that will fit on a floppy disk suitable for use in the drive of your machine (in the case of dual floppy drive machines, a 5.25" floppy with a maximum memory storage capacity of 360K).

Can the authoring language incorporate and interact with high resolution monochrome and color graphics monitors and adapter cards (Hercules monochrome cards and CGA, EGA, and VGA color cards)?

Again, the newer computers support higher resolution VGA monochrome and color monitors and VGA (Visual Graphics Array) adapter cards. The resolution of VGA monitors will allow the courseware developer to utilize a greater variety of higher resolution graphic displays within the program.

Is the software user-friendly?

Many computer users operate their machines on a “need-to-know” basis and do not have a full understanding of the computer, the operating system, or the technical aspects and limitations of the machines. Therefore, for the novice courseware author, it is wise to choose software that is user-friendly, with well written documentation that is easy to read and understand.

What are the actual costs for the purchase and use of the authoring language program?

The advertised price of the software may not always provide information on the actual costs for the use of the software or for the use of the final product (Collins, 1989a). The prospective courseware author should take into consideration the following:

1. How expensive is the authoring software relative to other available software packages?
2. Does the cost of the authoring software limit its use to only one computer or can it be used on all computers within the institution?
3. Will a site license have to be purchased to allow the use of the developed software on all campus machines?

   Site licenses can be very expensive but, in some cases, provide the only alternative, as multi-user fees are even more expensive to purchase. Some site licenses restrict the use of the software to institutionally-owned machines and may even restrict the area of use (in km) covered by the license.

4. Are there additional fees for each user of the developed courseware?

   Some authoring language software companies require payment of separate fees for each user of the developed courseware, even though you have authored the software. The prospective author must also be aware of the fact that the overall cost will increase, in terms of equipment and user fees, with the number of workstations used to run the courseware.

5. Are there additional costs if the courseware is developed and marketed for commercial distribution?

   You may find that you are not permitted to distribute the software beyond the restrictions of the license and you may have to purchase a distribution license which, in itself, may include additional restrictions for distribution. Many firms will charge special licensing fees for courseware authors wishing to market products created with the authoring program.

6. What additional hardware or peripherals will have to be purchased to fully use the software?

   Peripheral requirements would include all the accessories that are required for the successful operation of the authoring software (e.g., mouse, scanner, graphics tablet, drawing program, special color monitors).

7. What options or enhancements are available within the base price or additional to the base price?

   These could include tutorial software, limited time technical assistance (phone support), a font library, an advanced features library that may include advanced graphics routines, drivers for various hardware and for interfacing to other software or peripherals, sample programs or programs that can be edited for use, graphics packages that can be incorporated into the courseware, font editors (to create and modify fonts), and text editors. Many of these enhancements are available for the authoring software — for extra cost.

8. What are the estimated costs of future upgrades for the authoring software and how frequently will upgrades have to be purchased to take advantage of the enhanced features?

   Some companies will charge an annual maintenance fee for the use of their products. This may be either a fixed fee or a percentage of the total fees paid for the authoring software. The maintenance fee may permit the purchaser to obtain free software and documentation updates.

   Additional to the purchase of authoring software updates would be the costs involved in upgrading the hardware and software capabilities of the computers used to run the courseware. This may involve upgrading the computer's memory (more RAM beyond 640K), monitor (replace monochrome with VGA color), disk drives (low density to high density 5.25" or 3.5"), or hard disk (increased capacity for program storage and file creation) to accommodate the enhanced features of the software upgrade.

To summarize, the purchase of authoring software is not just a matter of selecting a product and purchasing it. The potential author should consider:

- a comparison of the various authoring software on the market,
- the intended use of the authoring software,
- the various uses of the final authored courseware,
- estimating all costs involved,

- hardware and software requirements of the authoring software,
- estimating modifications to existing computer hardware, and
- estimating license fees.

If the above are taken into consideration, then what should potential authors be looking for in an authoring software package? Based on the current research of Collins (1991a, 1991b), when selecting an authoring program for potential use, the following should be considered:

The authoring software should have the ability to:

- incorporate different types of questions (multiple choice, short and long answer),
- evaluate the precision of the response by the user (detection of misspelled, extra, or missing words, detection of capitalization errors),
- make judgements on equivalent answers to responses,
- scan in external text and graphics,
- print out materials for students,
- interface with peripheral equipment (audio and video players, videodisc players, etc.),
- perform editing on the screen, and
- draw simple figures (lines, boxes, circles, etc.).

The authoring software should be able to make use of:

- mathematical calculations in the program,
- alternate character sets (for graphic symbols),
- bold, superscripts, and subscripts within the text,
- text, graphics, and split screens,
- monochrome or color displays,
- graphics capabilities (CGA, EGA, VGA),
- animation,
- a wide range of colors and color sets,
- alternate text fonts, and
- external graphics packages.

Approach to the Development of the Courseware

Questions to ponder before undertaking courseware development:

1. Are there areas in your teaching program that could benefit from the use of computer courseware?

   The teaching and training requirements should be identified and planned in advance. Consultation and discussion with other teaching staff should occur to consider if, where, and when computer courseware could be utilized in courses or academic programs.

2. Who is to use the courseware and would it be used extensively and effectively?

   Identify the target audience and the ability levels of the students who will use the courseware. Determine if the courseware can be effectively incorporated into the teaching program.

3. What is to be taught?

   Determine if the courseware is to be based on the mastery of knowledge, facts, skills, or task analysis. Courseware development could include:

- the use of biological models with application analyses,
- measurement of manipulative skills (manipulation of variables, etc., within a simulated laboratory experiment),
- observation skills (e.g., simulated experiment),
- oral/written communication skills (description, explanation, summary, discussion),
- text-based information,
- simulated experiments with a written summary of conclusions by the student, and
- measurement and analyses (graphs, tables, quantification of data).

4. What level of instruction is needed to interact with the courseware?

   The developer will have to identify the beginner, intermediate, and advanced levels of instruction for use within the target group.

5. How is the material to be presented and taught?

   This may require the developer to design lesson plans, teaching strategies, presentation techniques, and tests of understanding (see Appendices C and D). Incorporated into the software should be:

   - measurable objectives (key words: compare, evaluate, contrast, analyze, summarize, interpret, prepare),
   - clearly defined evaluation procedures, and
   - an indication of the degree of interaction between the student and the computer.

6. What resources are to be used?

   In addition to the computer and the courseware, determine if the target group will be required to use a textbook and peripheral equipment (audio or video players, video disk players, printers, graphic plotters, a mouse, graphic tablet, etc.).

7. Assessment of the effectiveness of the software.

   The courseware will have to be evaluated by a test group or by field testing to determine its effectiveness and usefulness. Revision, re-editing, and field testing will have to occur.

8. Who will develop and write the software?

   Generally, the responsibility falls on the instructor to write the courseware, if it is deemed desirable for use in a specific laboratory, course of study, or biology program. This can impose a tremendous burden on the potential author, as the courseware will have to be designed with educational and instructional objectives in mind, an authoring language will have to be purchased and learned, and a courseware program will have to be written (programmed), edited, revised, field tested, and marketed for student use.

   However, there are alternatives in courseware development. One strategy that we have used successfully is to utilize a team approach to the creation and development of the courseware. In many educational institutions, there are students, faculty, and staff with programming expertise who would welcome the opportunity to be part of courseware development. The ideal situation is to select a team consisting of the course instructor (the instructional designer and content expert), programmers (to write the program for the courseware), graphic artists (to draw the graphics for use by the courseware), and field testers (individuals who will test the courseware in educational settings). This approach can prove to be very successful and rewarding as it combines the expertise of a number of individuals, decreases the time taken to create, develop,

and write the courseware, and has the potential to provide a quality product that could be used in a variety of learning situations.

Courseware Development

The development of instructional courseware does not necessarily require the creator to learn complex computer programming languages. Many authoring programs currently available in the software market can do most of the complex programming for you. Most are not difficult to learn and have the capabilities of producing high quality instructional courseware.

However, a basic understanding of computers and programming is essential. Prospective courseware developers should attempt to:

- develop a good working knowledge of the computer intended for use with the courseware (especially the newer 386 and 486 computers),
- be familiar with the operating system of the computer,
- have some knowledge of BASIC (a programming language), and
- have access to technical expertise for computer and software set-up (especially with the newer 386 and 486 microchip machines which have extensive set-up screens with variable parameters), connecting peripherals (printers, scanners, mice, video cameras, etc.), and computer-related problems.

The authoring-language program chosen to develop and write the CAL courseware for the demonstration programs shown at this workshop was PC/PILOT (Personal Computer Programmed Inquiry Learning Or Teaching) developed by Larry Kheriaty (Washington Computer Services, Bellingham, WA 98226). PC/PILOT is an authoring-language software program especially designed for instructional software development. It permits an instructor to create a CAL learning module using the full capabilities of a computer (see Appendix E). The CAL module can be tailored to the specific needs of both the students and the instructor.

The system requirements for PC/PILOT include any model IBM PC or compatible with 256K RAM, DOS 2.0 or higher, and a CGA (Color Graphics Adapter) monitor. An EGA (Extended Graphics Adapter) monitor is recommended. An Apple version of the PILOT authoring language is available.

PC/PILOT was chosen on the basis of research by Collins (1991a, 1991b) who has evaluated a number of authoring languages currently in use for the development of instructional courseware. The demonstration courseware used in this workshop was developed and written by Michael Collins and Peter Earle (Department of Biology, Memorial University of Newfoundland).

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APPENDIX A
Additional Reading

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APPENDIX B
Memorial University's Courseware Programs

The IBM-compatible courseware programs listed below have been developed at Memorial University by Michael Collins and Peter Earle using PC/PILOT. A number of these programs are still in the field testing stage and have yet to undergo revision and final editing.

IBM-compatible *courseware that is available:*

Kingdom Monera
Plant Biology
The Cell
DNA Replication
Taxonomy
Cell Transport
The Kidney
Heat Exchangers
Osmosis and Diffusion
Mitosis
Alternation of Generations
Evolution and Speciation
Protein Synthesis

IBM-compatible *courseware that is in development:*

Phylum Porifera
Phylum Platyhelminthes
Phylum Cnidaria
Phylum Nematoda
Phylum Annelida
Phylum Mollusca
Phylum Echinodermata
Phylum Arthropoda

APPLE II *courseware that is available:*

Scientific Method
Transport
The Kidney
Mitosis
Genetics
DNA Replication
Taxonomy
Plant Transport
Respiration
Cycles
Speciation
The Cell
Muscles
Nerves
Meiosis
Protein Synthesis
Enzymes
Energy Flow
Photosynthesis
Population Ecology
Evolution

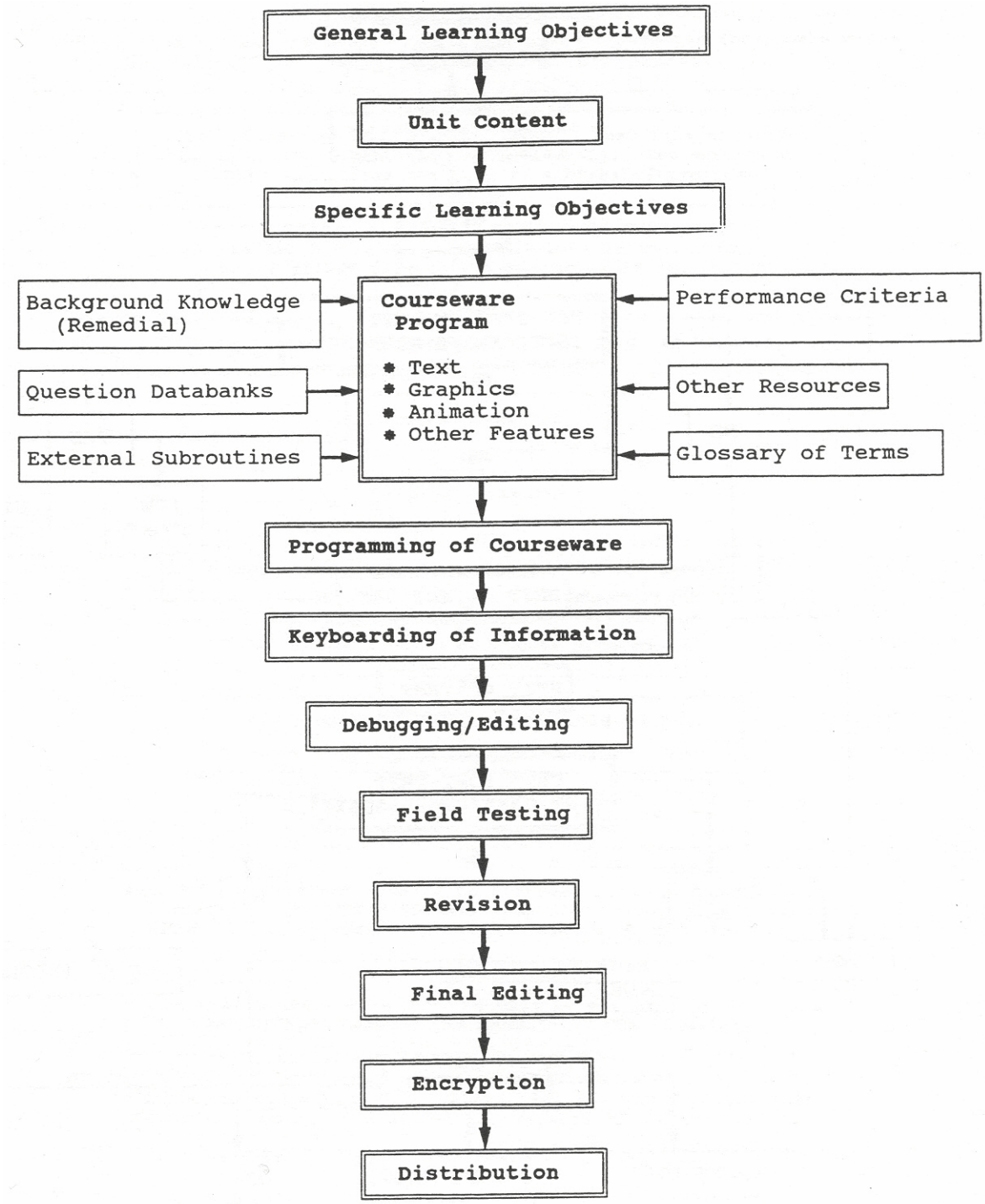
Commodore 64/128 *courseware that is available:*

Ecology
Material Recycling
Cell Division

APPENDIX C

CAL Lesson Planning:

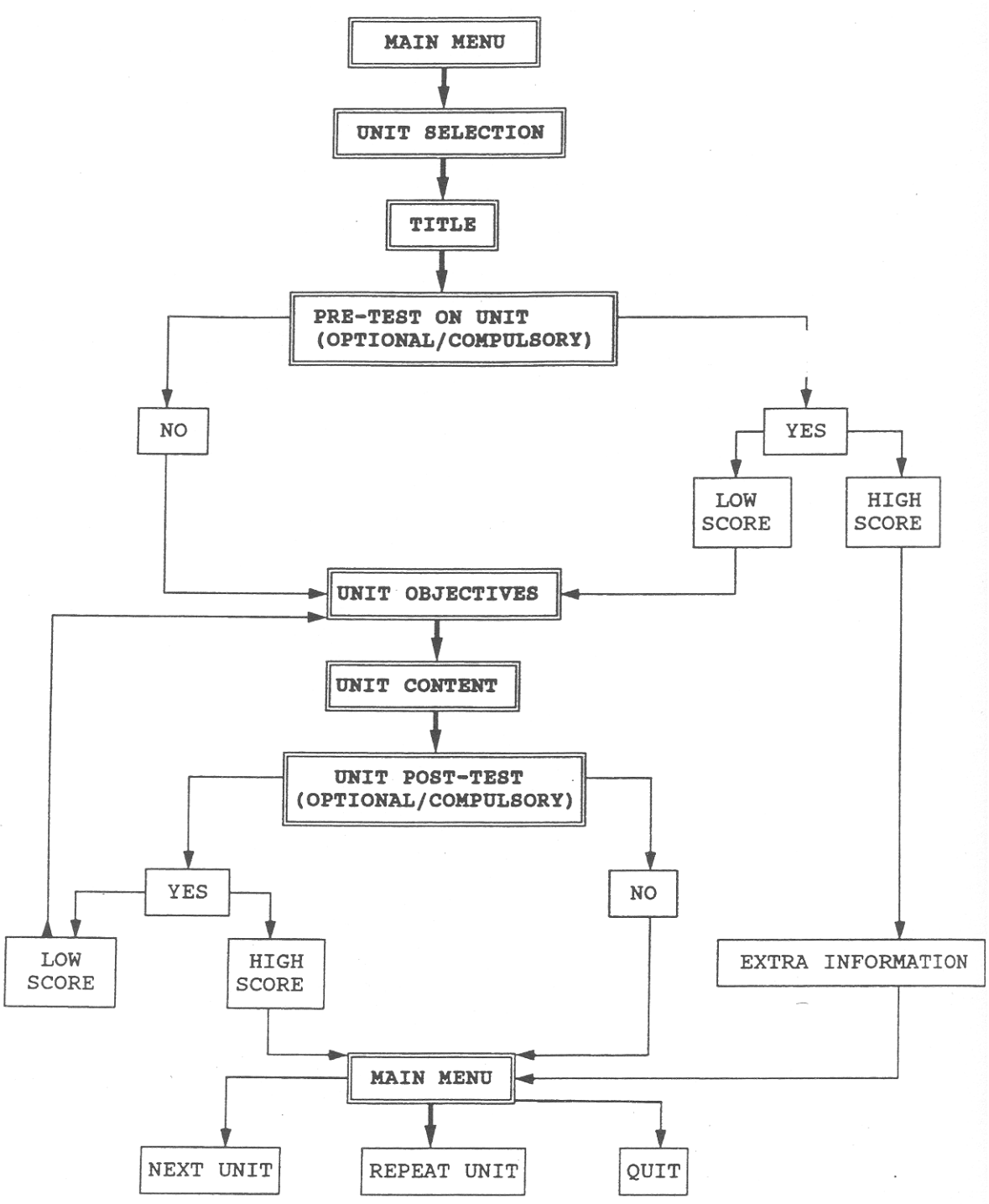
*Design and Sequence of **Instructional** Lesson – An Example*



APPENDIX D

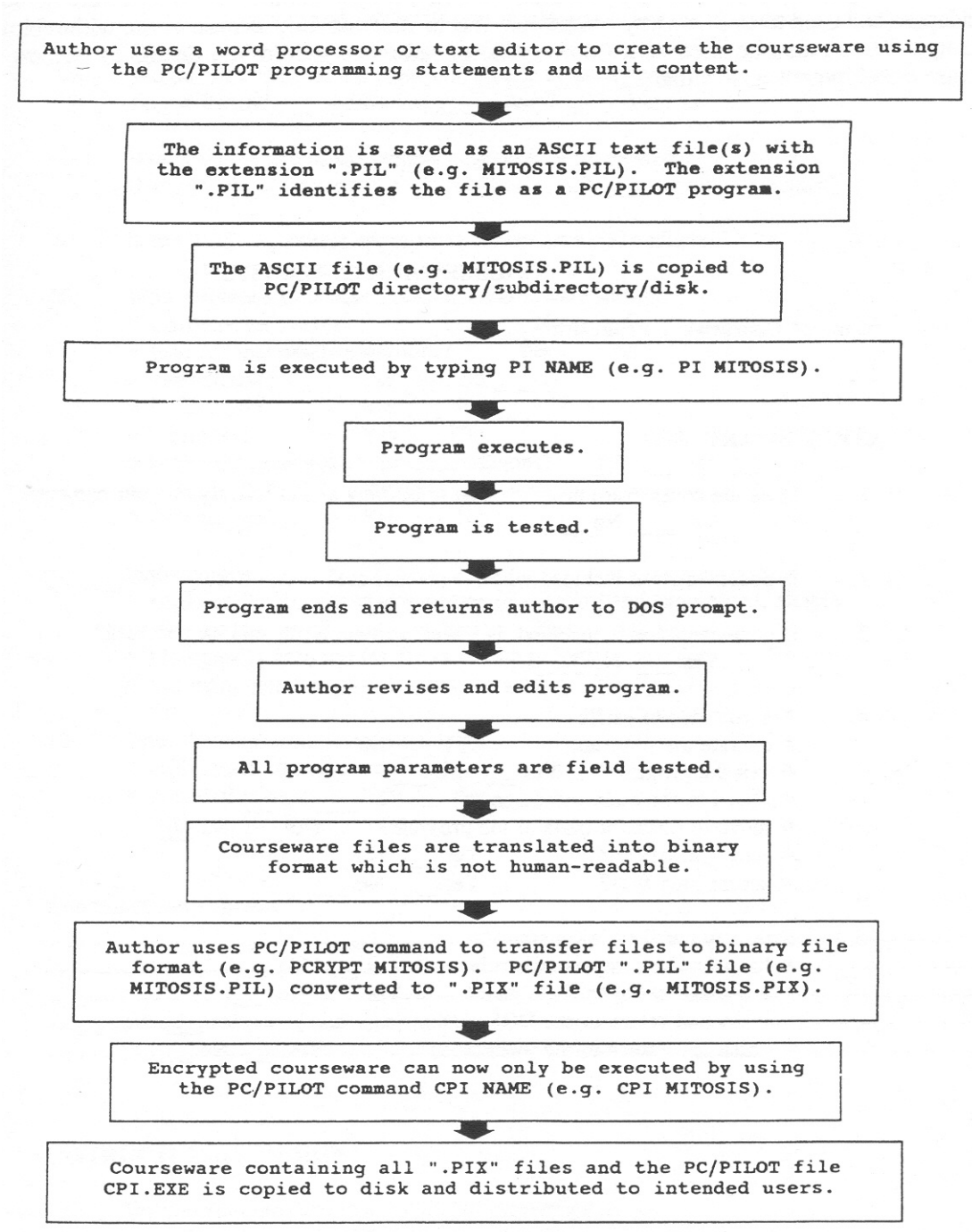
CAL Lesson Planning:

*Design and Sequence of **Courseware** Lesson – An Example*



APPENDIX E

Courseware Production with PC/PILOT – An Overview



APPENDIX F
Courseware Evaluation Questionnaire

The following questionnaire may be of assistance in the evaluation of the courseware demonstrated. It can be adapted and used to evaluate any courseware that is intended for purchase or use within biology courses or programs. It can also be used as a future guide or reference should you decide to become involved in courseware development or evaluation.

COURSEWARE EVALUATION

Name of Courseware Program: _____

COURSEWARE USE

1. Does the courseware program load effectively and efficiently on your computer?
   Yes ___ No ___

2. Is documentation included with the courseware? Yes ___ No ___

3. If documentation is included, is it well written, clear, and easy to read?
   Yes ___ No ___

4. Are you able to easily
   - operate the program? Yes ___ No ___
   - exit the program? Yes ___ No ___
   - return to the main menu screen? Yes ___ No ___
   - move to different parts of the program? Yes ___ No ___
   - access instructions? Yes ___ No ___
   - access help files? Yes ___ No ___

5. Does any part of the courseware
   - hang-up the computer when in use? Yes ___ No ___
   - crash and re-set the computer? Yes ___ No ___
   - crash and return to the DOS prompt (e.g. B:>)? Yes ___ No ___
   - crash and return to the main menu? Yes ___ No ___

COURSEWARE CONTENT

6. Is the sequence of content presented to the viewer appropriate for the intended audience (Introductory Biology- College Level)?
   Yes ___ No ___

7. Would the design of the content sequence be considered
   very difficult? ___ difficult? ___ easy? ___ very easy? ___

8. Would the design of the content sequence be considered
   abstract? ___ concrete? ___ skill oriented? ___
   mastery oriented ___

9. Is the depth of content appropriate for the intended audience?
   Yes ___ No ___

10. With reference to content, does the courseware include
    - instructional details? Yes ___ No ___
    - instructional practice sessions? Yes ___ No ___
    - definitions? Yes ___ No ___
    - explanations? Yes ___ No ___
    - examples? Yes ___ No ___
    - sufficient exercises for practice sessions? Yes ___ No ___
    - tests? Yes ___ No ___
    - illustrations? Yes ___ No ___

11. Is the content
    - readable for the intended audience (e.g. short and simple text, simple vocabulary)? Yes ___ No ___
    - biologically accurate (as far as can be judged)? Yes ___ No ___
    - following good English language usage? Yes ___ No ___

12. Does the courseware content allow for
    - individualized instruction? Yes ___ No ___
    - remedial learning? Yes ___ No ___
    - enrichment? Yes ___ No ___

Comments on Content

_____

_____

_____

_____

INSTRUCTIONAL DESIGN

13. Do you find the interaction with the courseware
    very difficult? ___ difficult? ___ easy? ___ very easy? ___

14. Does the courseware include instructions on use and interaction?
    Yes ___ No ___

15. Are the instructions well written and clearly stated?
    Yes ___ No ___

16. Does the courseware permit
    - manipulation of the content? Yes ___ No ___
    - passive ___ or active (interactive) ___ learning?
    - the correction of incorrect entries? Yes ___ No ___

17. Do you think that the program is sufficiently effective to promote learning of the incorporated biological concepts? Yes ___ No ___

18. With reference to questioning techniques used, does the courseware
    - provide appropriate questioning techniques designed for the intended audience? Yes ___ No ___
    - include questions appropriate to the content? Yes ___ No ___
    - allow questions to be randomly generated? Yes ___ No ___

19. With reference to the users' responses, does the courseware
    - accurately evaluate correct and incorrect responses?
      Yes ___ No ___
    - accurately evaluate alternate responses? (e.g. "N" instead of "No")
      Yes ___ No ___
    - provide non-threatening, positive feedback? Yes ___ No ___
    - provide hints, clues, or cues after an incorrect response?
      Yes ___ No ___
    - provide corrective suggestions for incorrect responses?
      Yes ___ No ___
    - allow a review of concepts after an incorrect response?
      Yes ___ No ___
    - use negative comments after incorrect responses?
      Yes ___ No ___

20. Can any aspects of the courseware be controlled or altered by the user or instructor (e.g. sequence, examples, content of tests, etc)?
    Yes ___ No ___

Comments on Instructional Design

_____

_____

_____

_____

TESTING

21. Does the courseware
    - utilize pre-tests? Yes ___ No ___
    - utilize post-tests? Yes ___ No ___
    - provide scorekeeping for each student? Yes ___ No ___
    - limit the number of scores or student records that can be recorded?
      Yes ___ No ___
    - provide information on the number of questions
      - attempted? Yes ___ No ___
      - correctly answered? Yes ___ No ___
      - incorrectly answered? Yes ___ No ___
      - provide a summary evaluation of the performance of the user for each part of the program? Yes ___ No ___
      - provide a graphic analysis of the performance of
      - individual students? Yes ___ No ___
      - the entire test group? Yes ___ No ___

22. Are the tests effectively designed to evaluate a mastery of the content presented in the courseware? Yes ___ No ___

Comments on Tests

_____

_____

_____

_____

TECHNICAL AND PROGRAMMING DESIGN

23. Does the software use appropriately designed character sizes and fonts to enhance effectiveness and readability? Yes ___ No ___

24. Are the screen displays
    - user controlled? Yes ___ No ___
        - free from errors (incorrect character spacing, spelling, punctuation, hyphenation)? Yes ___ No ___
    - crowded with information? Yes ___ No ___
    - clear and easy to read? Yes ___ No ___
    - utilizing special screen features for emphasis?
        - blinking ___ • reverse video ___
        - scrolling ___ • split screen ___
    - timed for viewing text information? Yes ___ No ___

25. Does the courseware incorporate
    - color? Yes ___ No ___
    - good color combinations? Yes ___ No ___
    - graphics? Yes ___ No ___
    - sound? Yes ___ No ___

26. Are the colors and/or graphics effective on the monitor that you are using (color emphasizes text or diagrams; graphics are clear, and of good quality)?
    - monochrome? Yes ___ No ___
    - color? Yes ___ No ___

27. If graphics and colors are used, are they effective as a motivational instrument?

Yes ___ No ___

28. If graphics and colors are used, do they effectively represent the intended graph, object, or idea? Yes ___ No ___

29. Are any of the following incorporated into courseware screens
    - full ___ or half ___ use of screen?
    - title line at top of screen? Yes ___ No ___
    - instruction line at bottom of screen? Yes ___ No ___
    - scrolling text ___ or screen paging? ___
    - large text for readability? Yes ___ No ___
    - short lines of text? Yes ___ No ___

- wide margins on either side as visual reference points?
  Yes ___ No ___
- double-spaced text? Yes ___ No ___
- headings? Yes ___ No ___
- underlined text? Yes ___ No ___
- boldface text? Yes ___ No ___
- periodic changes in typefacing for visual effect?
  Yes ___ No ___
- changes in text placement for visual effect? Yes ___ No ___
- highlighting of blocks of text? Yes ___ No ___
- animation? Yes ___ No ___

Comments on Technical and Programming Design

_____

_____

_____

_____

PEDAGOGICAL EVALUATION

30. Is the courseware appropriate for the intended audience (Introductory Biology - College level)? Yes ___ No ___

31. Are general courseware objectives present? Yes ___ No ___

32. Are courseware objectives clearly stated at the beginning or at appropriate sections in the program? Yes ___ No ___

33. Are the courseware objectives specific in their statements?
Yes ___ No ___

34. Are the courseware objectives reasonable with respect to the intended audience?
Yes ___ No ___

Comments on Courseware Objectives

35. Would this courseware be of use in your course or program?
Yes ___ No ___

36. Could this courseware be incorporated into your biology program?
Yes ___ No ___

37. If incorporated into your biology program, would it be used to

• supplement lectures?	Yes ___ No ___
• supplement laboratories?	Yes ___ No ___
• provide remedial opportunities?	Yes ___ No ___
• provide enrichment opportunities?	Yes ___ No ___

38. Indicate the learning categories that apply to this courseware (check all that apply).

• drill	___	• general knowledge-based	___
• practice	___	• factual knowledge-based	___
• tutorial	___	• skill oriented	___
• simulation	___	• task oriented	___
• exercise	___	• remedial	___

39. What additional materials (e.g. software, hardware, etc.), time, and preparation would be required to incorporate and use this courseware effectively in your biology program? (PLEASE LIST)

_____
_____
_____
_____

_____
_____
_____
_____

MAJOR STRENGTHS OF THE COURSEWARE

MAJOR WEAKNESSES OF THE COURSEWARE

COMMENTS ON THE QUESTIONNAIRE