# Appendix 1

## Examples of tasks and questions used in exploratory study 1

## Level 1 Questions

What should you always do after going to the toilet?

a) wash your hands
b) change your uniform
c) wear gloves
d) leave the door open for the next person

At work if you are not sure how to fry fish should you?

a) ask a friend
b) ask the supervisor
c) leave it and do something else
d) guess what to do and have a go

When you take a message on the telephone for someone should you?
Pick two answers

a) try to remember the message
b) write the message down on paper
c) write down their name and phone number
d) tell the message to a friend

Which of the following are the duties of a supervisor at work
pick two of the following?

a) changing the menu each day in the restaurant
b) organising staff
c) cooking the difficult dishes
d) helping staff to work properly

## Level 2 Questions

Explain below what you should do after going to the toilet

_____
_____

Explain below why you should wash your hands after going to the toilet

_____
_____

Write down two important duties of a supervisor

_____
_____

Why is it important to write down telephone messages properly for people at work
pick the best two answers?

a) so that information can be passed on properly
b) because it makes the company look efficient
c) so that the call can be returned
d) it is not really that important

## Level 3 Questions

Write down THREE important things you should do when taking a telephone message

1_____
2_____
3_____

Your supervisor is not in the room. Explain what you would do if someone hurt themselves in an accident

_____
_____

A workmate finds some of their belongings missing, Explain what you would do if you were her supervisor

_____
_____

## Level 1 task

Look at the following menu

| | |
|---|---|
| sausage | onions |
| gravy | creamed potatoes |
| peas | runner beans |

1) Write out the ingredients for 4 portions
2) Write out an order for the ingredients

## Level 2 task

Look at the following menu

| | |
|---|---|
| sausage | onions |
| gravy | creamed potatoes |
| peas | runner beans |

1) Write out the ingredients for 4 portions
2) Write out an order for the ingredients
3) Cost the ingredients
4) Calculate a selling price to make a 60 percent gross profit

## Level 3 task

You have to produce a lunch (single course) for 4 people within a budget of £0.85 per head

1) Produce two menus, each with meat, potato, 2 vegetables and a suitable sauce and garnish
2) Write and cost the list of ingredients for one of the options
3) Calculate a selling price to make a 60% gross profit
4) Write and order the ingredients
5) Prepare the meal for restaurant (check with your tutor first.)

# Appendix 2

## Questionnaire used in exploratory study 1

## Multimedia Course Evaluation Sheet

**If you need help to fill in this form, please ask your tutor**

User ID .....
Date:.....
Course:.....

*Please answer all questions by ticking the best options.*

*Rank the following questions about the course you have just taken, on a score of 1 to 5,* ***where 5 is exceptional and 1 is poor***

1 **How interesting did you find the course?**

| Very | | | | Not very |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

2 **How easy was the course to follow?**

| Very | | | | Not very |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

3 **How enjoyable was the course?**

| Very | | | | Not very |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

4 **Do you think that you learned anything from the course?**

| Much | | | | Not much |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

5 **Were the following useful or not useful to you in the course?**

**Working on your own**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Working in pairs**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Working in groups**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Working with the tutor**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Tests taken ON the computer**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Tests taken OFF the computer

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Tasks done ON the computer

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Tasks done OFF the computer

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Final test or examination

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

6 How worried were you by the following?

Using a computer

| Not Worried | | | | Very Worried |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Using a mouse

| Not Worried | | | | Very Worried |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Using headphones

| Not Worried | | | | Very Worried |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Working in a Learning Centre

| Not Worried | | | | Very Worried |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

7 Would you like to take similar multimedia courses in other subjects?
Y / N

*Thank you for taking part*

# Appendix 3

## Evaluation objectives developed in exploratory study 2

## The following objectives were developed in order to construct evaluation tools

### 1. Assessment of Learning and Pedagogy

Were specific learning objectives supported by the application?
Were targets achieved or not?
Did material support constructivist learning?
Were applications interactive and task-based?
Could learners contribute to their own learning?
Did computer system integrate well with other systems in place?
Were tutors involved in the course?
Was content accurate and appropriate?
Was course material, assessment, etc. at the appropriate level?
Was the use of the media appropriate or not?

### 2. Interface design / usability testing

Could users start, login and logout of packages easily?
Were users with disability supported?
Were applications robust?
Was unnecessary cognitive overhead avoided?
Were instructions clear and easy to follow?
Could users navigate, locate and orientate easily?
Did users always know what to do next?
Were users able to perform required tasks easily?
Did learners have sufficient computer experience?

### 3. Interest and User Satisfaction

Did learners like using the application?
What features of the course were judged to be good or bad?
Were screens clear and attractive?
Did applications have the right 'look' and 'feel'?
Were media of high quality?
Did the media add to the course?
Were materials interesting or boring?
Were materials interactive or passive?

# Appendix 4

## Expert evaluation tool developed in exploratory study 2

# Evaluation of Multimedia Materials
# Guidelines

The following is a set of guidelines for expert evaluation of multimedia learning materials. They are intended to be used at the same time as you follow the course. Please work through the evaluation completely for each application you are using by filling in the following questions. Please make comments freely in the spaces provided, or attach extra sheets if necessary.

1

Evaluator.....
Date .....
Application title .....
Windows 3.1 / 95 (delete one)

2

Installation (skip section if software was already installed)

How easy was it to install the software?
Did the application install successfully first time?
Did you have or need technical assistance with installing:
a) the software
b) the computers
c) multimedia equipment
Please comment freely on any feature of installing and setting up the software, hardware, operating system or multimedia equipment you consider important.

3

Logging In

Students log in by selecting the Student Login option. Did this always work correctly? If not, what problems did you encounter?
How could logging in be improved in the application.
Please comment freely on any feature of logging in that you consider important.

4

Performance
Was the application robust or did it crash? If it crashed, under what circumstances (machine type, memory, Windows version (3.1/95) What else was running, error messages, CD ROM speed etc...). Please explain fully (continue on separate labelled sheets if necessary).
Did sound play well? (if not please give details as above, including details of sound card)
Did images and transitions from screen to screen run smoothly? – Please explain fully (continue on separate labelled sheets if necessary).

5

Usability

5.1

User Interface
- was it clear and simple?
- were there confusing areas? - please explain
- what would you add to the screens?
- what would you take away from the screens?
- please comment on access for students with disability?
- comment on the menu bar.
- was the interface easy to learn
- how easy was logging in and quitting for the learner?
- were instructions clear and easy to follow?
- did users always know what to do next? .
- were users able to perform required tasks easily?
- did learners have sufficient computer experience?

5 Navigation
- Were menus and maps easy to use
- Were they clear to follow
- Did they add anything to the materials
- Did users always know how to use them
- please make any other comments on how easy the
- application was to move around in?

6 Screen Layout –
- Was the user always directed to the correct focus –
- Comment on fonts, colours etc. –
- Comment freely on any aspect of screen design
- What features of the screens were judged to be good or bad?
- Did applications have the right 'rook' and 'feel'? .
- Were screens interesting or boring?

7 Sound
- How can the sound most easily be configured for the user.
- Please comment on any sound features you would like to see added
- Please comment on any sound features you would like removed.
- How was sound quality?
- Comment on sound effects
- Did sound lead you toward or away from the focus of the material?
- Comment on the sound configuration options
- Any other comments?

8 Video and Animation (Moving images)
- Please comment on any video/animation features you would like to see
- Are there any video/animation features you would like removed?
- How was video/animation quality?
- Comment on video/animation effects
- Did moving images lead you toward or away from the focus of the material?
- Any other comments on video/animation?
- Would you like to see more or less animation and video (comment freely).

9 Pedagogy
However, please comment freely or present any ideas you have on how learning is supported within the application?
Would you say the application was instructivist or constructivist? - please expand

10 General

What are the support implications in your college/institution in using such material?
How available is the necessary hardware to run this application?
Please comment freely on any aspect of the material not covered by the preceding guidelines, that you consider to be important.

# Appendix 5

## Data log file format developed in exploratory study 2

## Data log file format

| Field | Type |
|---|---|
| User ID | String [8] |
| Task level | Numeric |
| Question Level | Numeric |
| Sound configuration | Numeric |
| Log in time | Time |
| Log out time | Time |
| Section entered | Numeric |
| Name of section | String [20] |
| Time section started | Time |
| Time section finished | Time |
| Questions answered | Array of Numeric |
| Questions attempted | Numeric |
| Questions correct | Numeric |
| History | Array of Numeric [50] |
| Percentage course completed | Numeric |

# Appendix 6

## Questionnaire developed in exploratory study 2

## Multimedia Course Evaluation Sheet

**If you need help to fill in this form, please ask your tutor**

User ID .....
Date:.....
Course:.....

*Please answer all questions by ticking the best options.*

*Rank the following questions about the course you have just taken, on a score of 1 to 5,* ***where 5 is exceptional and 1 is poor***

1 **How interesting did you find the course?**

| Very | | | | Not very |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

2 **How easy was the course to follow?**

| Very | | | | Not very |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

3 **How enjoyable was the course?**

| Very | | | | Not very |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

4 **Do you think that you learned anything from the course?**

| Much | | | | Not much |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

5 **Did you feel the course was too slow, too fast or about right in its pace?**

| Too Fast | | About Right | | Too Slow |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

6 **Were the following items useful or not useful to you in the course?**

**Video clips**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Pictures**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Text**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Sound**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Course book**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Help screens**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**Working on your own**

| Useful | | | | Not Useful |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Working in pairs

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Working in groups

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Working with the tutor

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Tests taken ON the computer

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Tests taken OFF the computer

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Tasks done ON the computer

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Tasks done OFF the computer

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Task Screens

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Review Screens

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Question Screens

Useful Not Useful

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

7 How worried were you by the following?

Using a computer

Not Worried Very Worried

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Using headphones or speakers

Not Worried Very Worried

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Taking exam on a computer

Not Worried Very Worried

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

Using a mouse

Not Worried Very Worried

| 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|

8 How difficult was it to log in to the course?

| Difficult | | | | Not Difficult |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

9 How difficult was it to exit the course?

| Difficult | | | | Not Difficult |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

10 Did you find it easy to move about to different sections in the course?

| Easy | | | | Not Easy |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

11 How often did you need a break from the course?

- Less than half-hourly.
- About half-an-hour.
- More than-half-hourly.

12 Would you like to take similar courses in other subjects?

Y / N

*Thank you for taking part*

# Appendix 7

## Interview script developed in exploratory study 2

# Interview script

Course Title .....
Date .....
Student ID .....

Thank you for taking part in the interview. I am taping this short chat about the program you have just done. If this puts you off, please say so and I will take notes instead. I'd like to know what you thought of the course so that we can write better courses in the future.

Please answer the questions as fully as possible. If you have any comments to make at any time, feel free to say what you like.

1 How was the room was it: Comfortable or uncomfortable?

2 Did you have any problems getting into the room or was it easy to find and get into?

3 Please explain what the problems were if you had any.

4 Was the room too hot, too cold or about right?

5 Was it easy to see the computer screen or did you have any problems?

6 If so, what were the problems?

7 Have you used a computer before?

8 Tell me something about your experiences using computers in the past, for example what have you used them for, if anything.

9 Did you find it difficult or easy to log in to the program?

10 If you'd like to say something about logging in please do.

11 How easy was it to move about in the program, did you always know where you were or were you sometimes lost.?

12 Was it always clear what you had to do in the program, or were you ever uncertain.

13 Were the screens easy to see or were they difficult sometimes? If so, please say something about why they were difficult.

14 Were the colours attractive or would you prefer different ones. If so what would be your choice of colour?

15 Was the course easy or difficult to follow?

16 Did you find the sound useful or not in following the course? Please make any comments you like about the sound in the course.

17 How was it using the headphones, or did you use speakers?

18 Was the room noisy for you or was it about right?

19 Do you think that the pictures and videos in the course were a good idea or not? Wwhat would you have liked to see in the course?

20 Was the text on the screen easy to read or not? Please comment on the size of the text, the amount of information or the level of the language used. Was it easy or hard to understand for example?

21 Did the sound help you to follow the text or not?

22 Did you use the repeat sound button and if so how often?

23 Did you find the course too long, too short or about right?

24 Would you like to do other similar courses in the future.?

25 Were you at all worried by using a computer or was that not a problem for you. Say anything you like about using a computer in this way?

26 Was the teacher's introduction to the program about right, too much or too little?

27 Was the course interesting to follow or not?

28 What could we do if anything to make the course more interesting for you?

29 How much time did you spend at the computer?

30 Was this too long, too short or about right?

31 Do you think you learned anything from the course?

32 How does the course compare to other courses you have done, either on a computer or any other type of course?

33 Was there anything at all about the room, the computer or the program that you'd like to comment on?

34 Can you think of anything we could provide you with to make the course more enjoyable to follow, for example more detailed instruction, print outs or whatever.

35 If you could change one thing in the course, what would it be?

36 What was your most favourite part of the course?

37 What was your least favourite part of the course?

38 Please say anything at all about the course if you want to.

Thank you once again for taking part in this interview. I hope you enjoyed using the program and that you will be using others in future.

# Appendix 8

## Video script developed in exploratory study 2

**Video script**

Name..... Location.....
Course.....
Group.....
Date..... Start time ..... Stop time.....
Number of students in room..... Number of students on course.....

General instructions
**Environment** Scan the room to record room layout and to obtain a measure of light level and general noise level.

**Staff**
- Record inductions to sessions
- Record tutor / student interactions as they occur

**Application**
- Record a few screens
- Record any problems or crashes you see

**Students**
- Show the students working
- Identify group working and record examples of any student -student or student tutor interactions as they occur
- Look for students in trouble - e.g. doing nothing or staring at a screen - zoom in on examples of this and get the screens
- Show mouse and use of headphones
- Gain an impression of how the students are involved in the sessions
- Are they working hard? Look for examples of effort - high and low

**Structured session**
Ask three students to perform the following:

- Log in
- Logging out
- Navigate to the menu
- Navigate to a specified item
- Navigate back to main menu again
- Show the application map
- Use the map to navigate to and from a location
- Locate some information
- Perform a task
- Answer a question

**Finally** Scan the room again and look for changes in environment that have taken place.

# Appendix 9

## Language tools developed for experiment 1

# Language level tool for computer text

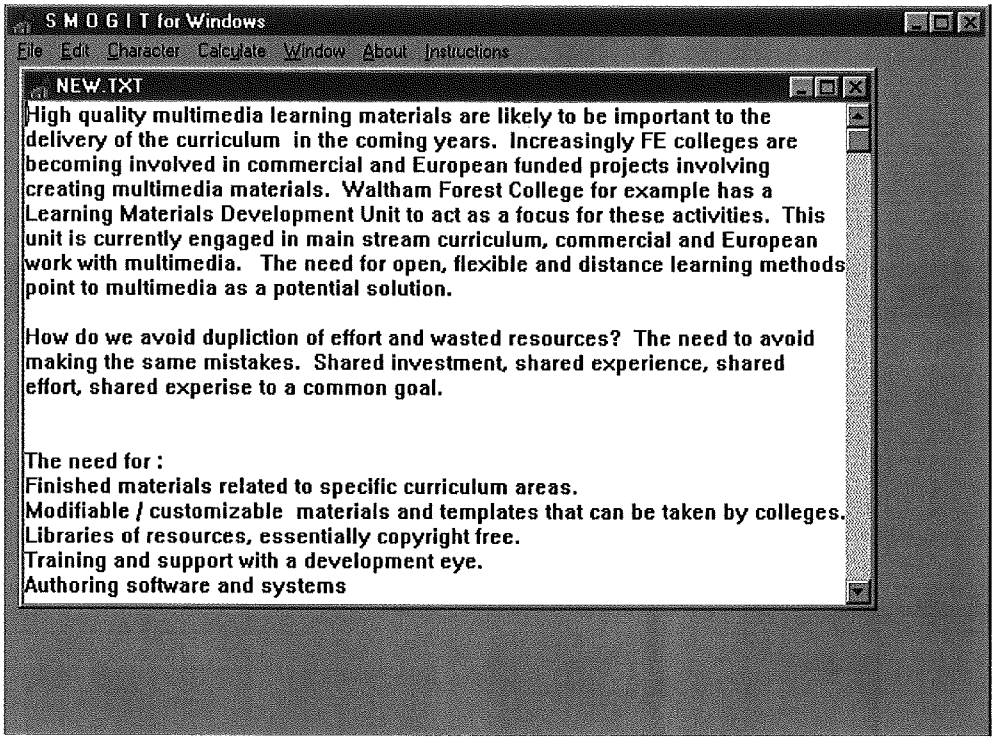



Figure A1 Language testing tool developed to test the language level of computer text.

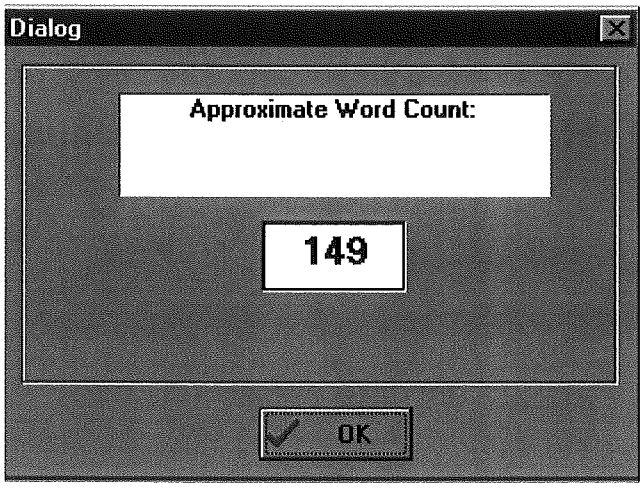



Figure A2 Output screen from language testing tool shown in figure A1, showing approximate number of words tested.

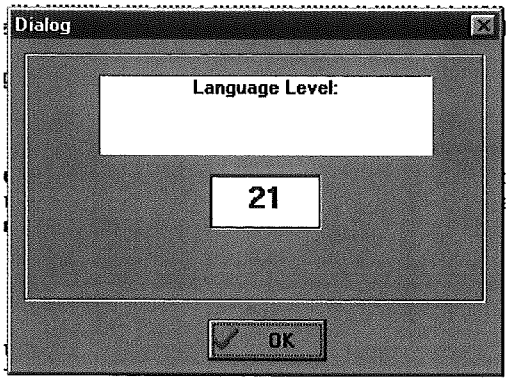



Figure A3 Language testing tool showing SMOG level of text passage

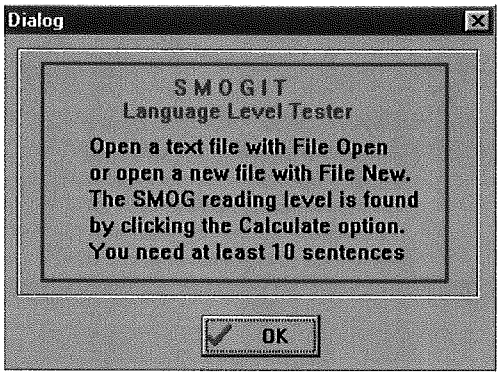



Figure A4 Simple instructions for users of text language level testing tool

**Language testing tool for participants**

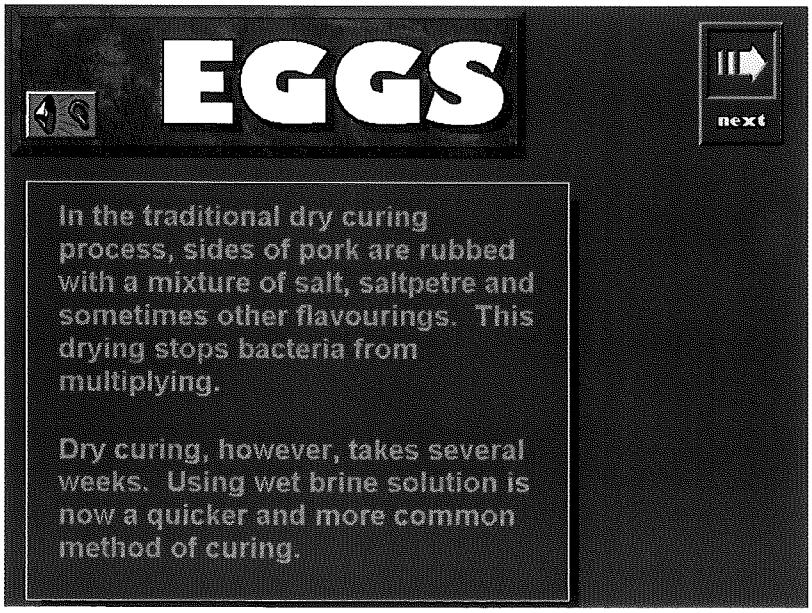



Figure A5 Sample screen from language testing tool for participants. .

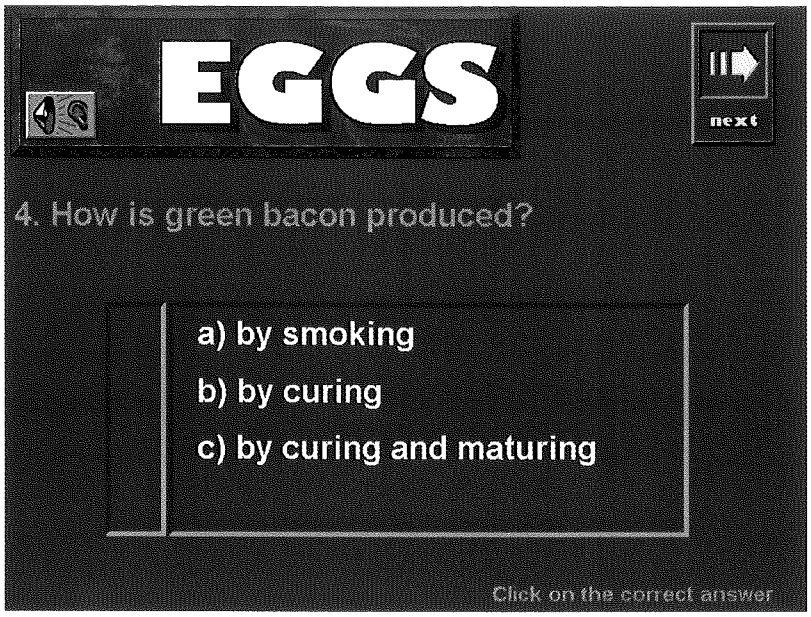



Figure A6 Multiple-choice answer screen relating to listening test in language testing tool for participants

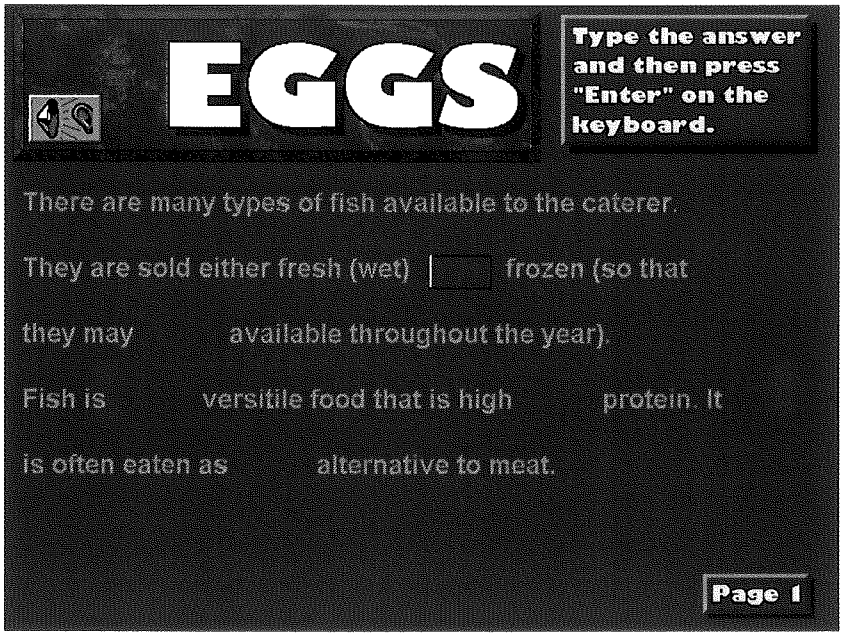



Figure A7 Gapping test used to measure reading skill level in language testing tool for participants

# Appendix 10

## Example pre-test, post-test, re-test, user evaluation and expert evaluation questions used in experiment 1

## Three sample pre-test questions

A grade one egg will have a weight of between?
a) 40 - 45 grams
b) 45 - 50 grams
c) 50 - 55 grams
d) 55 - 60 grams

What are grade C eggs used for?
a) pet food
b) pies and pastries
c) industrial processes
d) cheap restaurants

Which bacteria is associated with eggs?
a) Clostridium
b) Salmonella
c) Listeria
d) Staphylococcus

## Three sample post-test questions

What percentage of an egg is edible?
a) 80 percent
b) 85 percent
c) 90 percent
d) 95 percent

Which of theses is the nutrient in egg yolk?
a) protein, fat, vitamin A and D
b) protein, fat, water
c) protein, water
d) vitamin A and D, fat, water

Which of these is responsible for emulsification in mayonnaise?
a) gelatin
b) vinegar
c) lecithin
d) olive oil

## Three sample re-test questions

Which of these egg dishes will use a bain marie in cooking?
a) poached
b) sur le plat
c) en cocotte
d) mollet

Eggs should be stored in a
a) cold, very dry place
b) cold, damp place
c) cool, dry place
d) cool, not too dry place

When no cooking is involved, eggs should be
a) homogenised
b) pasteurised
c) sterilised
d) cleaned very well

## Multimedia Questionnaire
## used in experiment 1

### Questions

1 How interesting did you find the course?

2 How easy was the course to follow?

3 How enjoyable was the course?

4 Was the course too slow, too fast or about right?

5 Were the following items enjoyable or not enjoyable to you in the course?
Pictures
Text
Sound
Question Screens.

6 How worried were you by the following?
Using a computer
Using headphones or speakers
Taking tests on a computer
Using a mouse

7 How difficult was it to log in to the course?

8 How difficult was it to exit the course?

9 Did you find it easy to move about to different sections in the course?

10 How often did you need a break from the course?

11 Would you like to take similar courses in other subjects?

# Evaluation of Eggs Course Guidelines

Please work through the evaluation completely for the application by filling in the following questions. Please make comments freely in the spaces provided, or attach extra sheets if necessary.

Evaluator.....
Date .....
Application title .....

**Subject content**

Please comment on i) the appropriateness
ii) level
iii) accuracy

of the subject content of the application under the following headings:

a) Food hygiene
b) Nutrition
c) Food commodities studies
d) Cookery theory
e) Food science

In what other areas could it be used?
Please make any other comments on the subject content

**User Interface**
Was it clear and simple?
Were there confusing areas? - please explain
Please comment on access for students with disability?
Was the interface easy to learn?
How easy was logging in and quitting?
Were instructions clear and easy to follow?

did you always know what to do next? .
were users able to perform required tasks easily?

**Navigation**
Were menus and maps easy to use
please make any other comments on how easy the application was to move around in?

**Screen Layout –**
Comment on fonts, colours etc. –
Comment freely on any aspect of screen design
What features of the screens were judged to be good or bad?

Did applications have the right 'rook' and 'feel'? .

Were screens interesting or boring?

**Sound**
Please comment on any sound features you would like to see
How was sound quality?
Comment on sound effects
Any other comments about sound?

**Video and Animation (Moving images)**

How was video/animation quality?
Comment on video/animation effects
Any other comments on video / animation?
Would you like to see more or less animation and video? (comment freely).

Pedagogy

However, please comment freely or present any ideas you have on how learning is supported (or not) within the application?

Please make any other comments you feel will help in assessing the quality of this application

# Appendix 11

## Example of the interview used in expert evaluation in experiment 1

# Eggs Course

## Interview script

Evaluator.....
Date .....
Application title .....

Thank you for taking part in the interview. I am taping this short chat about the program you have been working with. If this puts you off, please say so and I will take notes instead. I'd like to know what you thought of the course so that we can write better courses in the future.

Please answer the questions as fully as possible. If you have any comments to make at any time, feel free to say what you like.

1 What courses do you normally teach on?

2 How did you like using the application? - **expand**

3 How will your students like using the application?

4 What was the screen design like - was it attractive or not and do you think it had the right look and feel for your students?

5 Please comment as fully as possible on the subject content of the eggs course

**Prompt for**
- was it accurate?
- how was the level for your students?
- did it cover the necessary range for your course?
- what would you add to the course?
- what would you take away from the course?

6 Did you always know where you were in the course or were there times when you felt lost?

7 Were you always able to locate the information you needed or were there times when you were unable to find information?

8 Could you always move to the section of the course you needed to with ease, or did you get lost on occasions?

9 Were there any unexpected happenings as you followed the course? **Please expand**

10 Was the course easy to use or not? - if not please explain

11 Did you have to put a lot of effort in learning to use the course or was it more or less self explanatory?

12 Do you think that information was well structured and available in the course or did you feel things were hidden from you?

# Appendix 12

## Text-based and image-based sections of the course developed in experiment 2

## Text and Image based sections of the application developed for experiment 2

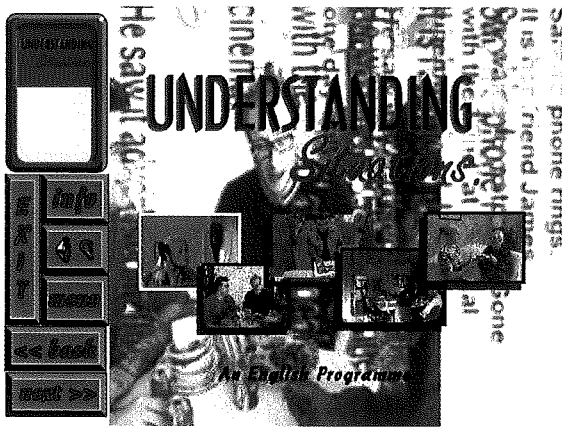



Figure A8 Introductory screen for the application developed and used in experiment 2


Figure A9 Text-based section of the application developed and used in experiment 2

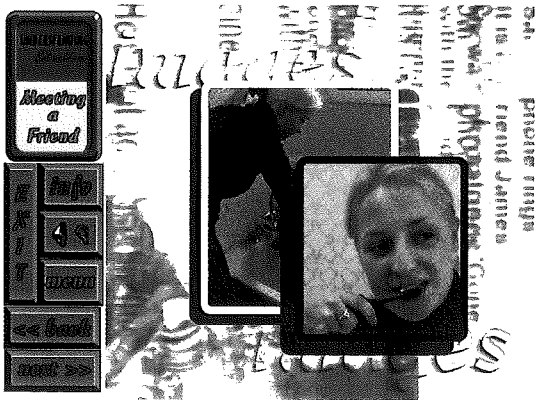
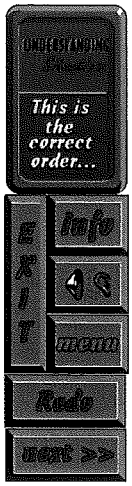



Figure A10 Image-based section of the application developed and used in experiment 2

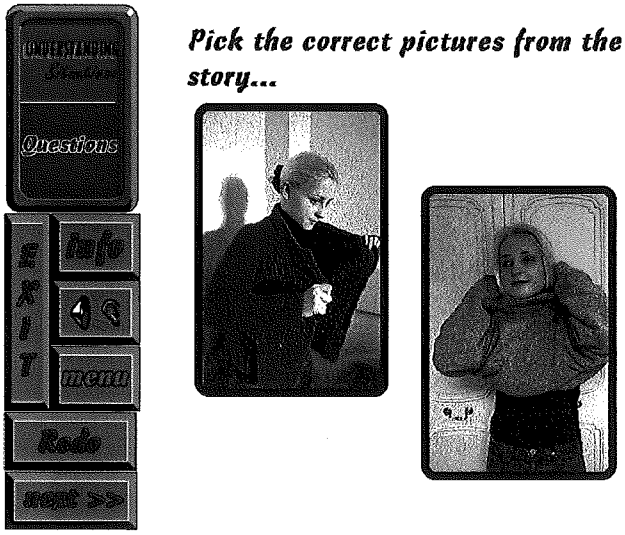



Sarah's phone rings.
It is her friend James.
He wants to go to see 'Gone with the Wind' at the local cinema. He saw it advertised in the paper. It is a special showing, one day only.
Sarah checks her diary to see if she is free on February the 22nd. It is a Saturday, yes she is free.
She says she will meet him there at 6.30pm and she writes it down in her diary.
The day arrives.
Sarah gets herself ready.
She has a bath and brushes her teeth.
She chooses her blue jumper from the wardrobe and puts it on.
Finally Sarah brushes her hair and she is ready to go.
She leaves the house at ten past six so she has plenty of time to walk to the cinema.
She is a little early but James is already waiting for her outside the cinema doors.
Luckily there is no queue, so they pay at the cash desk and go to watch the film.

Figure A11 Summary of story presented as narrative in the application developed and used in experiment 2


Figure A12 Summary of story presented as image sequence in the application developed and used in experiment 2


Figure A13 Question about the story presented in text format




*Pick the correct pictures from the story...*

Figure A14 Question about the story presented in image format

# Appendix 13

## Multimedia questionnaire used in experiment 2

## Multimedia Questionnaire
## used in experiment 2

### Questions

1 How interesting did you find the course?

2 How easy was the course to follow?

3 How enjoyable was the course?

4 Please rate how much you enjoyed the text-based sections of the course

5 Please rate much you enjoyed the image-based sections of the course

6 Please rate much you enjoyed the section of the course you chose yourself

7 Was the course too slow, too fast or about right?

a) In image sections of the course
b) In text sections of the course

8 Were the following items enjoyable or not enjoyable to you in the course?
Pictures
Text
Sound
Question Screens.

9 How worried were you by the following?
Using a computer
Using headphones or speakers
Taking tests on a computer
Using a mouse

10 How difficult was it to log in to the course?

11 How difficult was it to exit the course?

12 Did you find it easy to move about to different sections in the course?

13 How often did you need a break from the course?

14 Would you like to take similar courses in other subjects?

# Experiment 2
# Multimedia Questionnaire

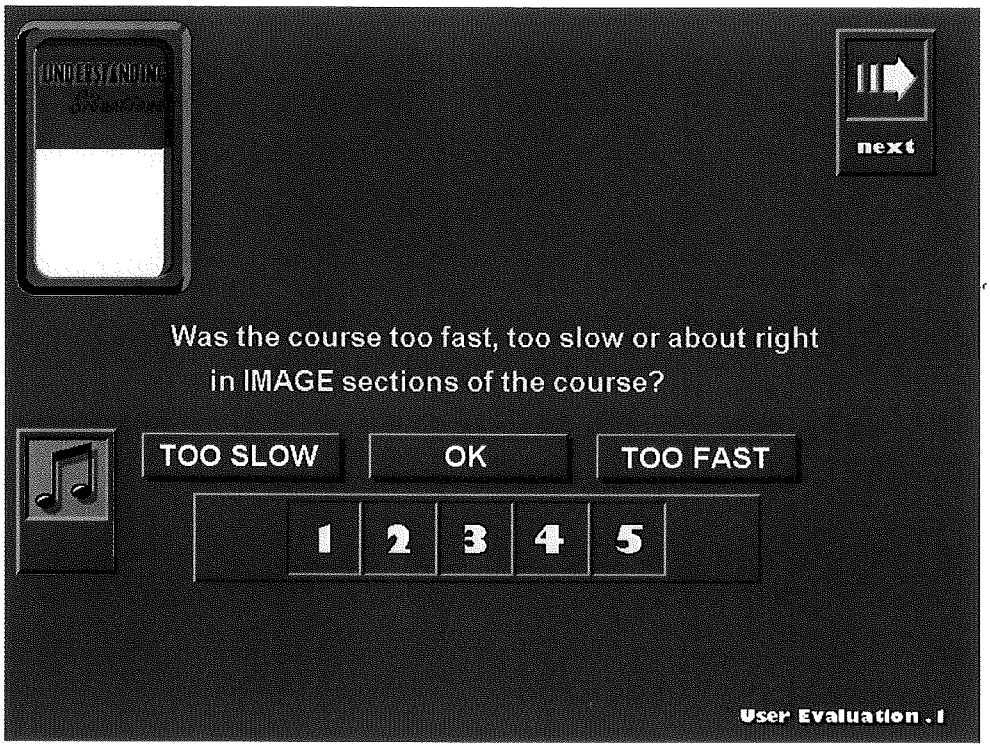



Figure A15 Sample screen from multimedia user attitude questionnaire used in experiment 2

# Appendix 14

## Questionnaires and results used in the preliminary study

## Expert evaluation of multimedia issues:

Please rate the following according to their importance in learning with multimedia materials.

(5 is important and 1 is not important)

**Colour scheme and layout**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

**High quality media**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

Please list any issues or factors you consider to be important in learning with multimedia materials not covered in this questionnaire.

Please indicate your role in College (Eg. manager, lecturer, library staff etc.)

**Results of the above questionnaire**
**Used in the preliminary study**

| | Role | | | |
|---|---|---|---|---|
| | Manager | Tutor | Support | Average |
| | 19 | 39 | 23 | 81 |
| Colour scheme and layout | 3.2 | 3.6 | 4.2 | 3.68 |
| High quality media | 4.1 | 3.9 | 3.5 | 3.83 |
| User satisfaction considered | 4.2 | 3.9 | 4.1 | 4.03 |
| Learning difficulties considerations. | 4.3 | 3.9 | 3.75 | 3.95 |
| Good subject content | 3.7 | 4.5 | 4.3 | 4.26 |
| Technical features of the application (bells and whistles) | 3.1 | 3.2 | 3.8 | 3.35 |
| Ability to track and record learners | 4.5 | 3.1 | 3.4 | 3.51 |
| Built-in assessment | 4.1 | 3.4 | 3.5 | 3.59 |
| Level of material appropriate | 4.2 | 4.3 | 3.9 | 4.16 |
| Learning material organised and structured | 3.6 | 4.1 | 3.6 | 3.84 |
| Learner always knows what to do next | 3.8 | 4.2 | 3.3 | 3.85 |
| Learner is in control of learning | 3.1 | 3.5 | 3.2 | 3.32 |
| Learner understands the learning context | 3.9 | 4.3 | 3.3 | 3.92 |
| Learning situated in vocational context | 3.5 | 4.1 | 3.3 | 3.73 |
| Learning situated in academic context | 3.3 | 4.2 | 3.4 | 3.76 |
| Linking to off computer assessment | 3.1 | 4.1 | 2.8 | 3.50 |
| Interesting and motivating material | 4.2 | 4.3 | 4.2 | 4.25 |
| Importance of off computer activities | 2.9 | 4.3 | 3.3 | 3.69 |

| | | | | |
|---|---|---|---|---|
| Support for high quality instruction | 4.4 | 3.7 | 4.0 | 3.95 |
| Use of built-in accreditation | 4.3 | 3.1 | 2.3 | 3.15 |
| Use of in-line questions | 3.4 | 3.9 | 3.3 | 3.61 |
| Use of Post-test to measure performance | 4.5 | 4.1 | 3.8 | 4.11 |
| Use of Pre-test to measure prior skill | 4.2 | 3.5 | 3.3 | 3.61 |
| Ability to configure language level for the individual | 3.1 | 4.2 | 3.2 | 3.66 |
| Ability to configure learning style for the individual | 3.2 | 4.0 | 3.3 | 3.61 |
| Ability to configure presentation order for the individual | 4.2 | 4.4 | 3.9 | 4.21 |
| Ability to configure question level for the individual | 3.2 | 3.8 | 3.1 | 3.46 |
| Ability to configure task level for the individual | 3.1 | 3.8 | 2.9 | 3.38 |
| Ability to configure help level for the individual | 4.4 | 4.6 | 4.1 | 4.41 |
| Case studies used extensively | 3.0 | 4.2 | 4.0 | 3.86 |
| Individual working encouraged | 4.2 | 4.1 | 3.9 | 4.07 |
| Group working encouraged | 3.2 | 4.4 | 2.9 | 3.69 |
| Constructivist learning encouraged | 3.8 | 4.3 | 3.1 | 3.84 |
| Learners able to configure features themselves | 4.2 | 4.2 | 3.8 | 4.09 |
| Materials designed to create challenges for the learner | 4.3 | 4.6 | 3.9 | 4.33 |
| Simulations used extensively | 3.8 | 4.1 | 4.2 | 4.06 |
| Task-based learning | 3.9 | 4.2 | 3.2 | 3.85 |
| Working with tutors | 3.4 | 4.3 | 3.2 | 3.78 |
| Tutor able to monitor and intervene | 4.1 | 4.2 | 3.2 | 3.89 |
| Availability of materials | 4.2 | 4.3 | 4.5 | 4.33 |
| Cost-effectiveness of material | 4.3 | 3.5 | 3.8 | 3.77 |
| Cost of learning with multimedia | 4.5 | 3.2 | 3.9 | 3.70 |
| Effectiveness of learning | 4.2 | 4.1 | 3.9 | 4.07 |
| Flexible learning | 4.6 | 3.9 | 4.5 | 4.23 |
| Learning efficiency | 4.4 | 3.3 | 4.1 | 3.79 |
| Need for high initial investment | 4.6 | 4.0 | 4.1 | 4.17 |
| Integration into existing systems | 4.1 | 3.9 | 4.3 | 4.06 |
| Pass and fail rate | 4.1 | 4.5 | 3.7 | 4.18 |
| Staff training issues | 3.9 | 4.3 | 3.9 | 4.09 |
| Need to work in learning centres | 4.3 | 3.8 | 4.7 | 4.17 |
| Requirement for support from institution | 4.7 | 4.3 | 4.5 | 4.45 |
| Mean score | 3.89 | 3.99 | 3.67 | 3.88 |

# Appendix 15

## Hierarchical structure developed in the final study

## HIERARCHICAL STRUCTURE

The following hierarchical structure was derived during the open and axial stages of the final study. The categories and subcategories displayed in the structure were used to assist in coding data obtained in the research around the core category identified in the phenomenon, 'the quality of learning'. Where possible variables have been assigned dimensions (a range of values).

Core category

**1.0 THE QUALITY OF LEARNING**

MAIN CATEGORIES

**1.1 The student model**

**1.2 The learning materials**

**1.3 The learning environment**

The main stakeholders in the phenomenon were identified as:

The learner
The tutor
The educational system

**The following sets out the relationship between categories, sub-categories and variables developed in the final study.**

### 1.1 THE STUDENT MODEL

#### 1.1.1 PERFORMANCE / RESULTS

Pre-test/Post-test scores
(Baseline measure)
(High score - Low score)
(Improvement measures)
On/Off computer tests
Comparison (same, equal, better)
On/Off computer tasks
Comparison (same, equal, better)

#### 1.1.2 COMPONENTS OF THE STUDENT MODEL

Language
Level (High or Low)

Cognitive style
Verbaliser Bimodal Imager
Task level
Levels 1,2,3
Question level
Levels 1,2,3
Scaffolding
Levels 1,2,3

### 1.1.3 CONFIGURING THE STUDENT MODEL

Configuring the descriptors in the model
Tutor involvement
(Highly involved - Not involved)
Target setting
Adapting
Co-operative model
Alternative models and methods
automatic adaptation
The student
Prior skills
(rich in skills - poor in skills)
Learner characteristics
Age
Gender
Learning difficulty
Other personal (not relevant)
Language
(good - poor)
Cognitive style
(Verbaliser - bimodal - imager)
Intelligence
(IQ level)
Other personal characteristics
Learning styles
Learning strategies
Learner preferences
Motivation
Intrinsic motivation
Extrinsic motivation
(motivated - not motivated)

Satisfaction with learning
Factors affecting perception
Interest
Success
(pass - fail)
(high - low score)
Context of learning
Relevance (perceived - not perceived)

Vocational (in context - out of context)
Learning (in context - out of context)
Preferences (in context - out of context)

Locus of control
Individual control
(controlled - flexible)
Tutor control
(tutor controlled - student controlled)
Control preference (highly controlled - no control)
Flexibility (flexible - controlled)
Objectives (known - unknown)
Attitude (good - poor)
Personal investment ( high - low effort)

## 1.2 THE LEARNING MATERIALS

### 1.2.1 SUBJECT CONTENT

Exam board considerations
Level
Performance criteria
Evidence
Accuracy
Security

### 1.2.2 DESIGN FEATURES

Quality
Text
Media
Script
Narrative
Content
Quality
Accuracy
Relevance
Context
Task type
Question type
Domain Level
Appropriateness
Technical features
Design
Sound
Video/animation
Interaction
Differentiation
Questions
Help/scaffolding

Task
Language
Cognitive style
Domain presentation
Screen design features
High quality - poor quality
Look and feel
(appropriate - not appropriate)

### 1.2.3 USABILITY

Robustness of application
Navigation
Orientation
Location
Ease of use
Learnability
Information hiding
Cognitive load

Relationship between learning and usability

### 1.2.4 LEARNING PRESENTATION STRATEGY

Collaborative working
Group work
Pair work
Working with the tutor
Individual work

Differentiation for the individual
The use of questions
related theory
The use of scaffolding
related theory
The use of tasks
related theory
Other materials involved in presentation of learning
Support material
Related materials
Other multimedia material
Quality
Availability
Integration
Theories of learning
Constructive
Cognitive influence
(Learner centred)
Instructive
Behaviourist influence

(Teacher centred)

Structure
- Theory of design
- Theories of instruction
- Theories of learning
- Support for mental models

Psychological factors aiding learning
- Multi-modal learning
- Cognitive load
- Challenge
- Information feedback
- Advanced organisers
- Frames
- Zone of proximal development

Questions and tasks used in learning
- Achievement
  - Results
  - Exams
  - Assessments
  - Tests
  - Tasks
    - (pass rate)
    - (score)

Scaffolding and help used in learning
- Individual configuration
  - (support - challenge)

Personal achievement
- Internal focus
- External focus
- Vocational focus

Student model in learning
- Question level
  - challenge - support
- Task level
  - challenge - support
- Language support
  - clarity
- Help/scaffolding
  - challenge - support
- Cognitive style
  - Verbaliser - Bimodal - Imager
  - Other cognitive or learning styles

## 1.3 THE MANAGEMENT OF LEARNING

### 1.3.1 THE TUTOR

- Tutor involvement
  - Integration
  - New methods
  - New roles
  - New skills
    - Assessment
    - Configuring the student model
    - Target setting
    - Team and group working methods
- Tutor characteristics
  - Attitude
  - Training
  - Flexibility
  - Objectives
  - Personal investment
    - Rewards

- Organisation
  - (highly organised - not organised)
- Control of learning
  - Configuration
  - Data logging
  - Assessment
  - Accreditation

### 1.3.2 THE LEARNING ENVIRONMENT

#### 1.3.2.1 The micro environment

- Local provision of facilities
  - Network
  - Hardware
  - Software
  - Location
    - Learning centre
    - Library
    - Computer room
    - Classroom
  - Support
    - Technical
    - Learning
      - Direct support
      - Indirect support
        - Support staff
        - Support facilities

Quality of environment
Effect of environment on learning
Effect of learning on the environment
Light
Noise
Heat
Screen reflection
Space
Suitability of location

#### 1.3.2.2 The macro environment

Strategic plan
Policy statement
ILT strategy
Central direction
Resources available
Central provision of facilities
Network
Hardware
Software
Support
Investment and allocation of resources
Competing influences
Other stakeholders
Needs analysis
Pressures
(real - perceived)
Central involvement
Co-ordinators
Support teams
Course teams
Top-down approach
Bottom-up approach
Cost
Cost-effectiveness
Cost-benefit
Cost-utility
Cost of falling behind
Cost efficiency
Funding opportunity
Cost of alternative strategies
Potential of commercial opportunities
Returns from increased student numbers
Returns from increased student retention
Reduction of staff replacement costs

Integration into existing systems
- Flexibility
  - Flexible learning
  - Open learning
  - Distance learning

Effectiveness
- Staff/Student Ratio
- Pass rate
- Retention
- Recruitment

Training
- Cost of training
- Staff recruitment
- Staff turnover
- Staff satisfaction

Change
- Revolution
- Evolution
- Managing change

Institutional objectives
- Attitude
- Publicity
- Marketing

External influences
- Inspection
- Government recommendations
- Funding bodies
- External reports

Support organisations

# Appendix 16

## Guidelines for the preliminary staff report described in chapter 7

# Staff Report

Thank you for agreeing to take part in this study. Please complete the following report ***after*** working through the Application of Number multimedia programme. The report is set out in two parts, a structured section with specific questions to answer and a section where you are invited to comment freely on any aspect of the issue.

**Name**..... **College**.....
**Date**.....

## Section 1

How would you describe your previous experience of working with multimedia learning materials prior to using this application?

What was you overall impression of the application?

Please provide notes on as many of the following features or issues as you can. Please relate your report to this application or to multimedia learning applications in general (please specify).

- Subject content
- Screen design and layout
- Use of colour
- Use of sound
- Use of video and animation
- Use of text
- Catering for learning difficulty and disability
- Differentiation
- Individual configuration of learning
- Student modelling
- Intelligent systems
- Constructive learning
- Instruction
- Learning context
- Group working
- On and off computer activities
- Management issues
- Institutional Issues
- The learning environment
- Training

## Section 2

Please comment in any way on issues related to multimedia that you feel were not approached in the previous section.

Would you be prepared to take part in a short interview? (Y or N)

# Appendix 17

## Scripts used for video recording sessions described in chapter 7

## Application of Number Video script

College..... Tutor.....
Recorder..... Location.....
Course..... Group.....
Date..... Start time.....Stop time.....
Number of students in room..... Number of students on course.....

**General instructions**

**Environment** Scan the room to record room layout and to obtain a measure of light level and general noise level.

**Staff**

- Record inductions to sessions
- Record tutor/student interactions as they occur

**Application**

- Record a few screens
- Record any problems or crashes you see

**Students**

- Show the students working
- Identify group working and record examples of any student-student or student tutor interactions as they occur
- Look for students in trouble - e.g. doing nothing or staring at a screen - zoom in on examples of this and get the screens
- Show mouse and use of headphones
- Gain an impression of how the students are involved in the sessions
- Are they working hard? Look for examples of effort - high and low

**Structured session**

Ask three students to perform the following:

- Log in
- Logging out
- Navigate to the menu
- Navigate to a specified item
- Navigate back to main menu again
- Show the application map
- Use the map to navigate to and from a location
- Locate some information
- Perform a task
- Answer a question

- **Follow the task script after completing the above**

**Finally:** Scan the room again and look for changes in environment that have taken place.

# Appendix 18

## Task scripts for video recording sessions described in chapter 7

**Application of Number** **Task script**

College..... Tutor.....
Recorder..... Location.....
Course..... Group.....
Date..... Start time.....Stop time.....
Number of students in room..... Number of students on course.....

Make sure the staff at the location are aware of the group activities.
Introduce yourself to students before each activity and explain what you are going to do.

**Group task** - record ONE group off computer
The group will be prepared to carry out the Conduct a Survey activity

Record the following - (5 minutes max) keeping in background

- How many in the group?
- Group organisation - who is leading?
- Activity level - who is doing what?
- Look for people not involved?
- Is the tutor involved? - provide examples if you can
- How did the session start?
- How did it finish (if it did)?
- Did the group use the script provided?

**Pair task** - record ONE pair of students
Pairs will already have been given the task to do

Record the following - get involved

- Is the tutor involved - provide example?
- How did the session start?
- Ask the students to talk about the task as they do it?
- How did it finish?
- Did the pairs use the script provided?

**Individual task** - record ONE individual
Learner can pick any on-computer task

Record the following - get involved

- Is the tutor involved? - provide example
- How did the TASK start?
- Ask the student to talk about the task as they do it
- Try to get a measure of effort and understanding
- How did it finish?

Look for and record examples of pair and group working not scripted.

# Appendix 19

## Student interview script described in chapter 7

# Interview script

**Application of Number**
Date .....
Student ID.....
Location .....

Thank you for taking part in the interview. I am taping this short chat about the program you have just done. If this puts you off, please say so and I will take notes instead. I'd like to know what you thought of the course so that we can write better courses in the future.

Please answer the questions as fully as possible. If you have any comments to make at any time, feel free to say what you like.

(N.B. Try to get a three point assessment e.g. better, same, worse)

1 Compared to other courses, how much did you enjoy working on the Application of Number course?

2 Compared to other courses, how did you find the work load of the course?

3 Compared to other courses, how difficult was the application of number course?

4 Compared to other courses, how easy were the tasks you had to do?

5 Compared to other courses how easy were the questions you had to answer on the computer?

6 Compared to other courses, how easy was the final coursework for the section you covered?

7 Compared to other courses how much time did you spend working on the course (more, the same, less)?

In the next section, please try to say whether the course was better than other courses, the same as other courses or worse than other courses for the REASON that I'll give you. For example if you think that working alone made the course better than other courses, say so, or if the course was worse than other courses because of working alone, tell me that. If you don't understand something, just say so and I'll explain more.

8 Compared to other courses the course was better/ the same / worse due to your attitude towards studying the course?

9 Compared to other courses the course was better/ the same / worse due to working alone?

10 Compared to other courses the course was better/ the same / worse due to working in groups?

11 Compared to other courses the course was better/ the same / worse due to working with the tutor?

12 Compared to other courses the course was better/ the same / worse due to being able to achieving targets?

13 Compared to other courses the course was better/ the same / worse due to knowing what to do next?

14 Compared to other courses the course was better/ the same / worse due to the Organisation of the course?

15 Compared to other courses the course was better/ the same / worse due to a sense of personal satisfaction?

16 Would have preferred more, the same or less computer time to work through the course?

17 Would have preferred more , the same or less lectures as you worked through the course?

18 Please comment in any way or say anything about the course you like. I will then ask you to talk a little more about the course?

Thank you for taking part

# Appendix 20

**Example pre-test and post-test questions used in the final study, described in chapter 7**

**Application of Number pre-test and post-test (example questions)**

**Add subtract multiply and divide whole numbers**

Addition

12 + 19
18.3 + 2.12
34.65 + 23.61

Subtraction

15 - 8
26 - 11
13.8 - 3. 7
23.6 - 12.9

Multiplication

3 x 5
4 x 12
12 x 15
12.4 x 16.3
127.2 x 1.6

Division

6 / 2
3 / 2
3 / 4
3.2 / 5
13.6 / 1.4

**Use reverse calculations to check a result**

Multiply the following numbers together and show your answer

15.4 x 33.6

Perform a reverse calculation to check your answer. Show your workings.

**Check that the result fits**

A person buys 4 cakes at 36 pence each. After doing the calculation, their pocket calculator shows 144. Without doing the calculation, explain how you could tell quickly where to put the decimal place.

# Appendix 21

**Learner questionnaire used in the final study, described in chapter 7**

## Application of Number Multimedia Questionnaire

### Questions

Were the course objectives - clear or not clear to you?

Did you have enough or not enough feedback?

How easy was the course to follow (Easy or Hard)?

Was the subject content of the course useful or not useful to you?

Was the course too slow, about right or too fast?

Was the course was well planned or poorly planned?

Was the language used difficult or about right or easy?

Was using the programme easy or hard?

Were questions on the course easy or hard?

Were tests and assignments fair or unfair?

Were tasks you had to do easy or hard?

Did you enjoy or not enjoy working in groups?

Did you enjoy or not enjoy explaining things to others?

Did you feel in control or not in control of your own learning?

Did you find working with tutor useful or not useful?

Did you find help systems useful or not useful?

Did you find use of images useful or not?

Did you find use of interactive activities useful or not?

Did you find use of video useful or not?

Did you find use of sound useful or not?

Did you find use of text useful or not?

Was Finding way around easy or not?

Did you find working at the computer useful or not?

Did you find working away from the computer useful or not?

Did you find facilities in room were good or bad?

I got what I wanted from the course completely or not at all?

I will be able to use what I learned on the course lots or little?

Content was too much or about right or too little?

I found the quality of the application ( high or low)?

Would you recommend the course to others (Y or N)?

## Application of Number Multimedia Questionnaire

### Sample screen

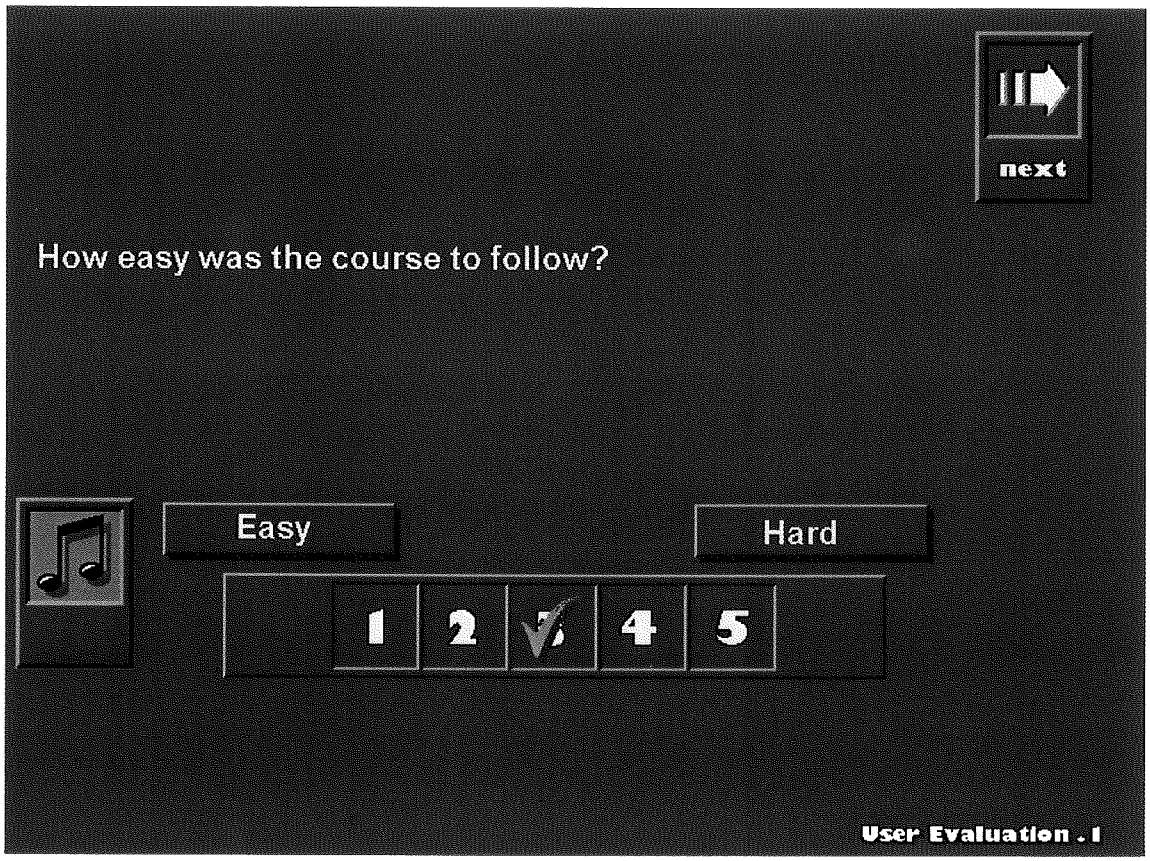



**Figure A16**

Sample screen from multimedia user attitude questionnaire used in the final study

# Appendix 22

## Focus group tool used in the final study described in chapter 7

## EVALUATION FOCUS GROUP PROTOCOL

Application of Number

Number of participants: _____ Location _____

Date: _____ Facilitator_____

### Instructions

Thank you for taking part in this discussion. The meeting is being recorded by _____ who I'd like you all to meet . If anyone objects to being recorded in this way, please say so now. Anything said here will be treated in confidence and the tapes will be erased at the end of the study.

The discussion is about the Application of Number course which some of you took using the computer and others followed in the more usual way. In this meeting, I will start the discussion and I would like you to discuss the topic I bring up in any way you like. I will interrupt from time to time, but I will try to let you do all the hard work. Some topics are intended especially for the multimedia course followers, but others please feel free to compare your experience with the other groups' experience. The idea is to compare what you thought of the course you followed.

(N.B. Make sure the following are covered in full)

- What is your opinion of the Application of Number course?
- Did you follow the course at times and places convenient to you?
- What could be done to improve the interactive multimedia system?
- Did you feel that the material was presented in the most appropriate mix of text and images for you personally?
- Were there too many pictures in the course?
- Were there too many words used in the course?
- Did you have trouble understanding the images, pictures or animations on the course?
- Which of these was most useful to you in helping you understand the course, text, spoken word, images or videos?
- In what way was sound important in the application for you?
- What was your experience of working on your own on your course?
- How difficult did you find the course you followed?
- What was your experience of working with tutors on the course?

Is there anything at all you would like to say about the course.

Thank you for taking part.

# Appendix 23

## Staff interview script described in chapter 7

# Interview script

## Application of Number multimedia course

Date .....
Tutor .....
Location .....

Thank you for taking part in the interview. I am taping this short chat about Application of Number course you were involved in. If this puts you off, please say so and I will take notes instead. The central question that is approached in this interview is the quality of the learning experience provided by the course. Please answer the questions as fully as possible. If you have any comments to make at any time, feel free to say what you like.

Please expand as much as possible

- Please comment on the initial needs of tutors involved in the project.
- How well do you think that students were prepared prior to the course?
- What was your attitude to configuring the student model?
- What problems did you encounter as you followed the course?
- What was your opinion of the Application of Number course?
- What was the effectiveness of the co-operative approach to the student model?
- What were student attitudes to the course?
- What was you attitude to following the course?
- What was your experience of the management of the process?
- What suggestions would you recommend for improvements in the system?
- Is there anything else at all would like to add?
- Please summarise in a few words your experience of the course.

Thank you for taking part in this study.

# Appendix 24

## Staff report used in the final study described in chapter 7

# Staff Report

Please complete the following report ***after*** completing the Application of Number course. The report is set out in two parts, a structured section with set questions and a section where you are invited to comment freely on any aspect of the course you wish.

## Section 1

Please provide a list of the main activities you undertook on the course, for example setting targets, marking work, and giving lectures. Please try to provide as complete a list as possible.

## Multimedia

What were the advantages of using multimedia in delivering learning on the Application of Number course?
Please comment on the technical support provided for you in supporting the delivery of the course, explaining how this influenced the quality of the course.
What were the disadvantages of using multimedia in delivering learning on the course?
Please comment on the technical support provided for you in supporting the delivery of the course, explaining how this influenced the quality of the course.
Please summarise your experience of delivering learning in this way on the Application of Number course.

## Student model

How important was the use of a configurable student model to students following the course?
What were the most useful variables in the student model?
What were the least useful variables in the student model?
What if any additional variables might be added to the student model in the future?

## Learning

Please report on the learning experience provided by the Application of Number multimedia course.
What is your opinion of the Application of Number course?

## Learning environment

Please comment freely on the attitude of your institution to the following issues as they relate directly to the integration of information and learning technology.

- Philosophy of your institution to ILT
- Philosophy of your institution to flexible/open/distance learning
- Your institution's attitude to cultural change
- Provision of support by your institution for ILT
- Staff training
- Technical support
- Provision of hardware
- Provision of software

## Role of the institution in promoting information and learning technology (ILT)

Please describe in a sentence or two under the following headings, how you perceive the role of your institution in promoting the use of ILT

The institution has:
- a whole institution approach to ILT
- a stated ILT policy
- a top down approach to ILT
- a bottom up approach to ILT

The institution provides:
- support for individual workers
- support from centre
- an effective point of contact

The institution adopts or fosters:
- an evolutionary approach to ILT
- a revolutionary approach
- a supportive atmosphere at work
- shared goals
- dissemination of achievements
- perception of success
- an individual approach to ILT
- a team approach to ILT
- the integration of ILT into existing courses

## Section 2

In thisection, please comment on any aspect of the quality of learning provided by the Application of Number course or by the use of multimedia or ILT in your teaching.

# Appendix 25

## Expert review guidelines used in the final study described in chapter 7

# Application of Number

The following are guidelines for the expert evaluation of the Application of Number multimedia course. They are intended to be used at the same time as you follow the course. Please work through the evaluation completely by rating the following statements on a scale of 1 - 5 according to whether you agree or disagree with the statement. A score of 1 represents no agreement and 5 complete agreement.

You are invited to make comments about any aspect of the application by attaching extra sheets if necessary, but please finish the structured part of the evaluation in full.

Evaluator.....
Date .....

## AREA 1 - INSTRUCTIONAL DESIGN REVIEW

This application provides learners with a clear knowledge of the program objectives.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The instructional interactions are appropriate for the objectives.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The instructional design was based on sound learning theory and principles.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application was constructivist in its design.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The feedback in this application is clear.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The pace of this application is appropriate.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The difficulty level of this application is appropriate.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Cognitive overhead was low.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application was task-based.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application was vocationally centred.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Help provided was good and at the correct level.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The use of language in this application was appropriate.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

On-line questions and tasks were good.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Off-screen activities were well planned.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application was differentiated.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application was individually configured.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

**AREA 2 - SCREEN DESIGN REVIEW**

The screen design of this application follows sound principles.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Colour is appropriately used in this application.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The screen displays are easy to understand.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Video and animation was useful.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Screen Layout was simple and effective.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application displayed high quality design features.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The use of sound was well planned.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

## AREA 3 - PROGRAM USABILITY REVIEW

This application operated flawlessly.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Navigation was simple.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Orientation was simple.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Searching for information was easy.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

The application response times were fast.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Logging in and out was flawless.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Creating new users was efficient.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Configuring the student model worked well.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

Data handling worked well.

| Agree | | | | Disagree |
|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 |

# Appendix 26

## Sample screens from the Application of Number course

# Appendix 26

## Sample screens from the Application of Number course

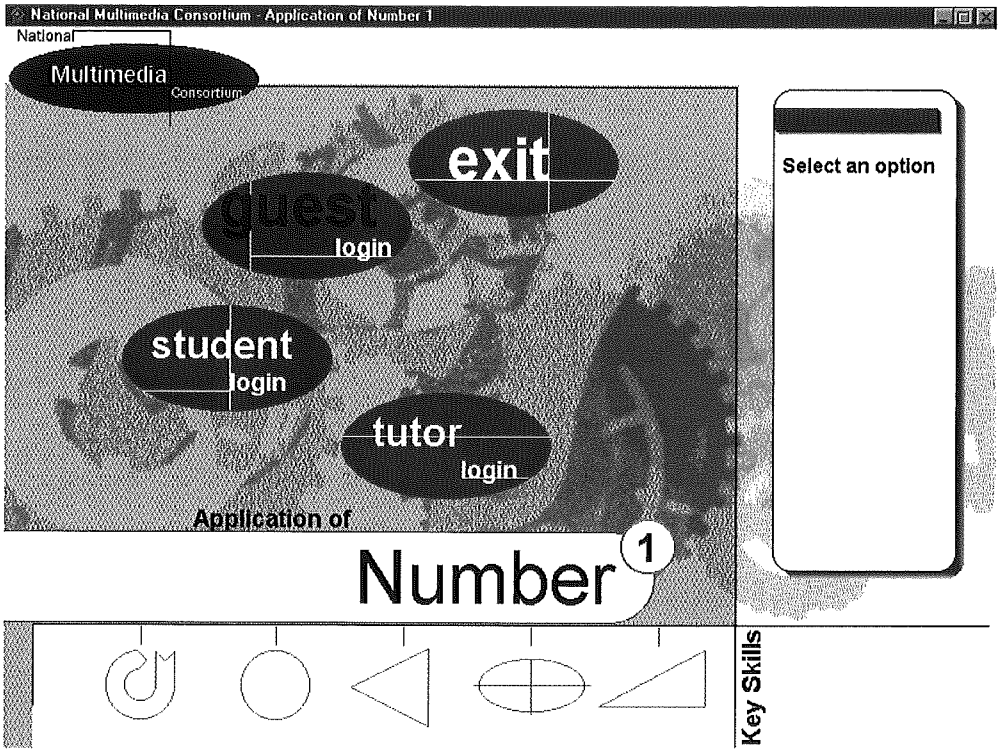



Figure A17 Log in screen for the Application of Number multimedia course

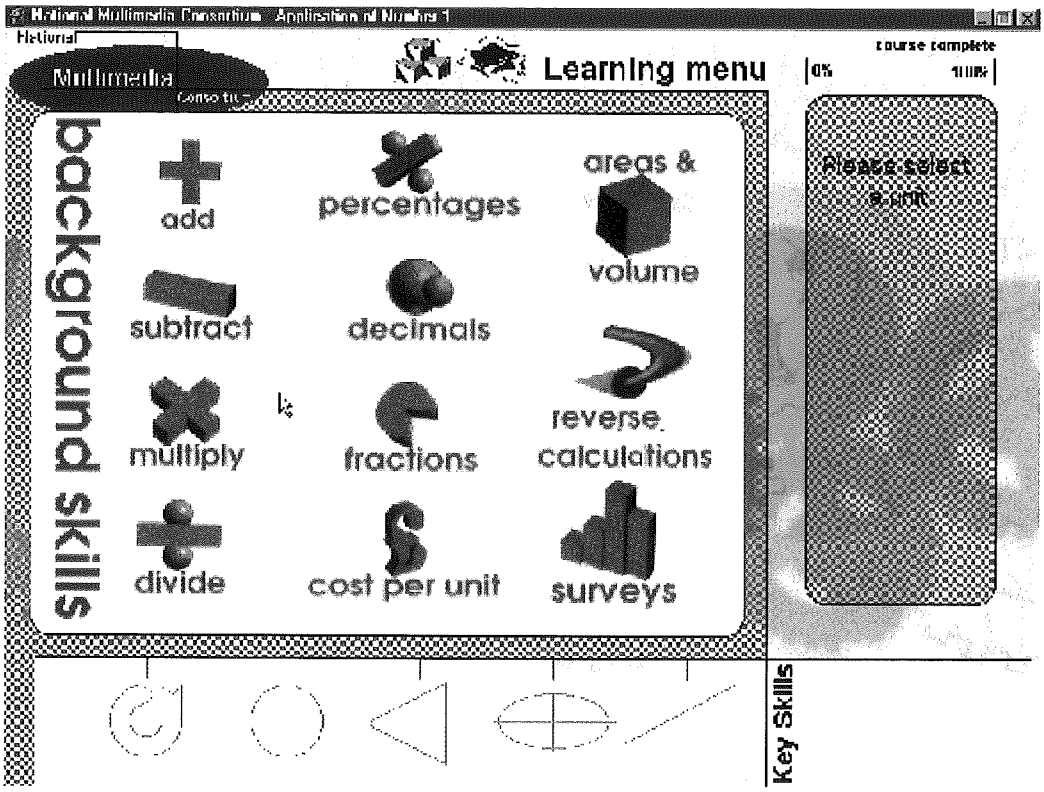



Figure A18 Screen allowing selection of background skills in the Application of Number multimedia course

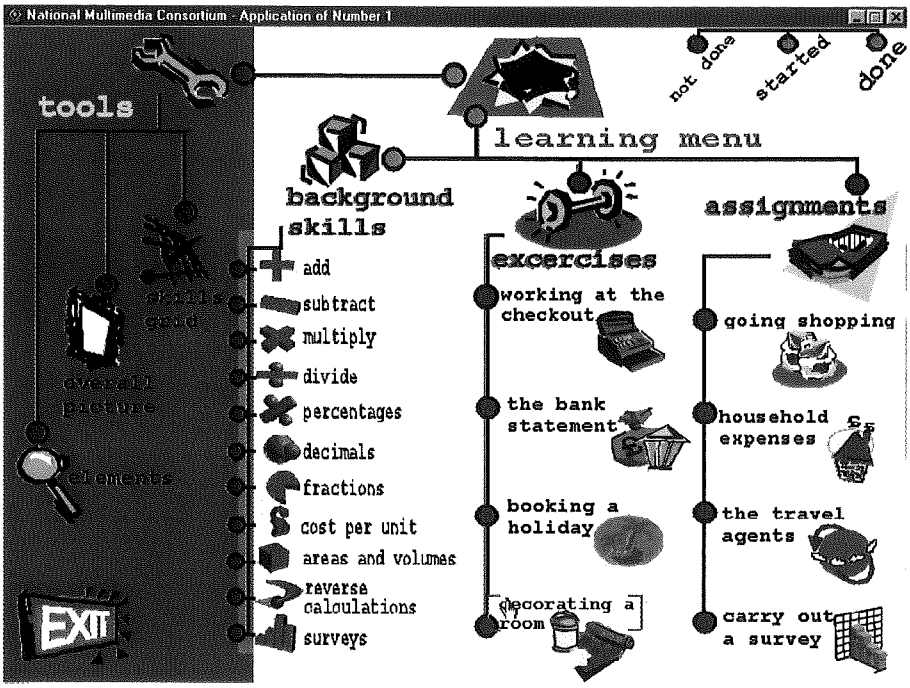



Figure A 19 Map allowing simple location, orientation and navigation within the course

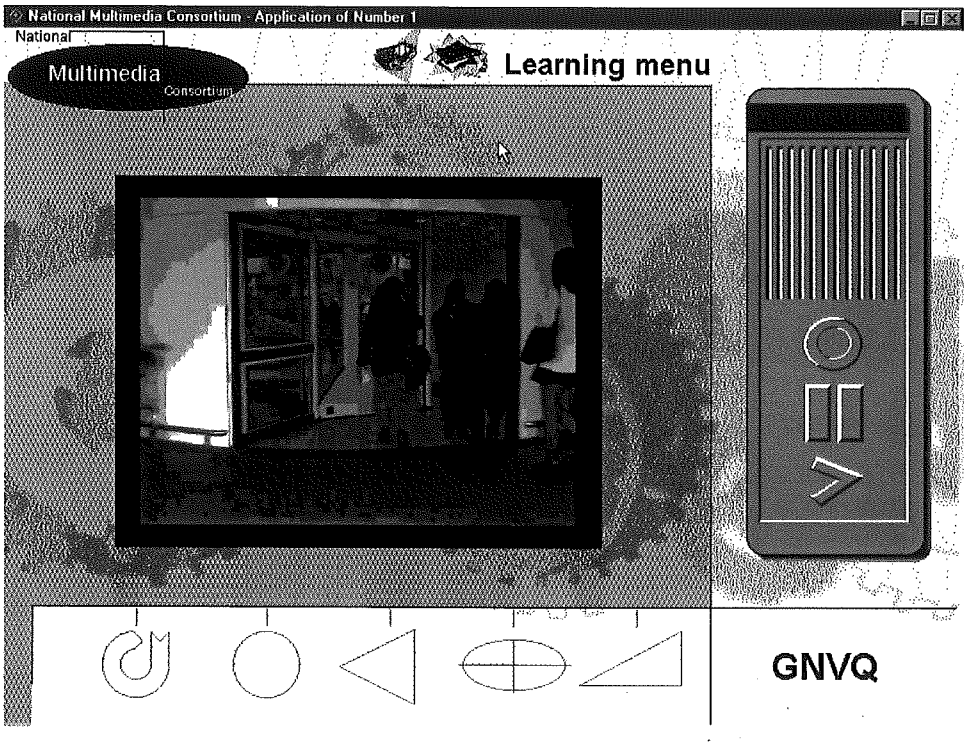



Figure A 20 Setting the scene for an assignment. High-quality video related to assignment one - Going Shopping

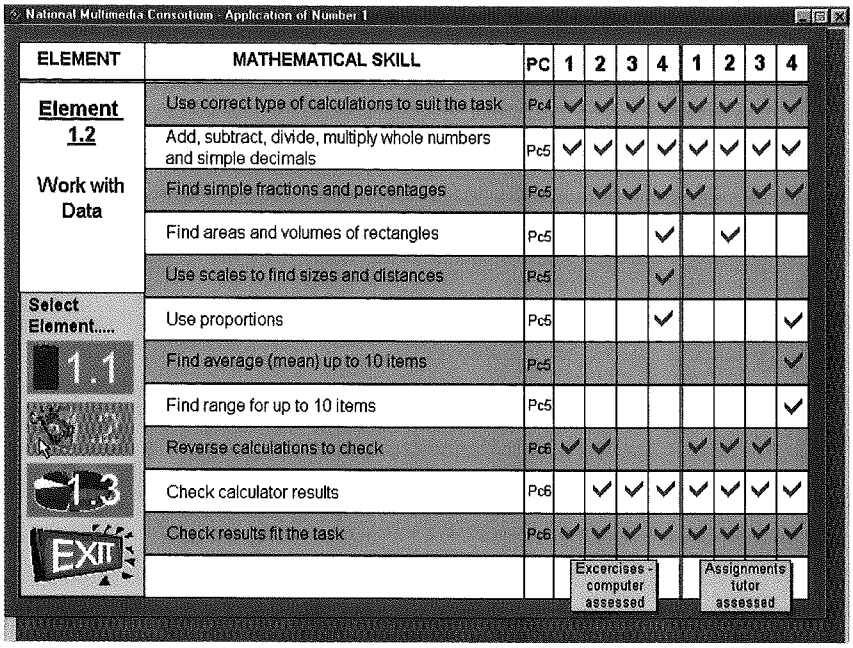



Figure A 21 Skills grid to help staff and learners to organize and plan their work in the Application of Number course

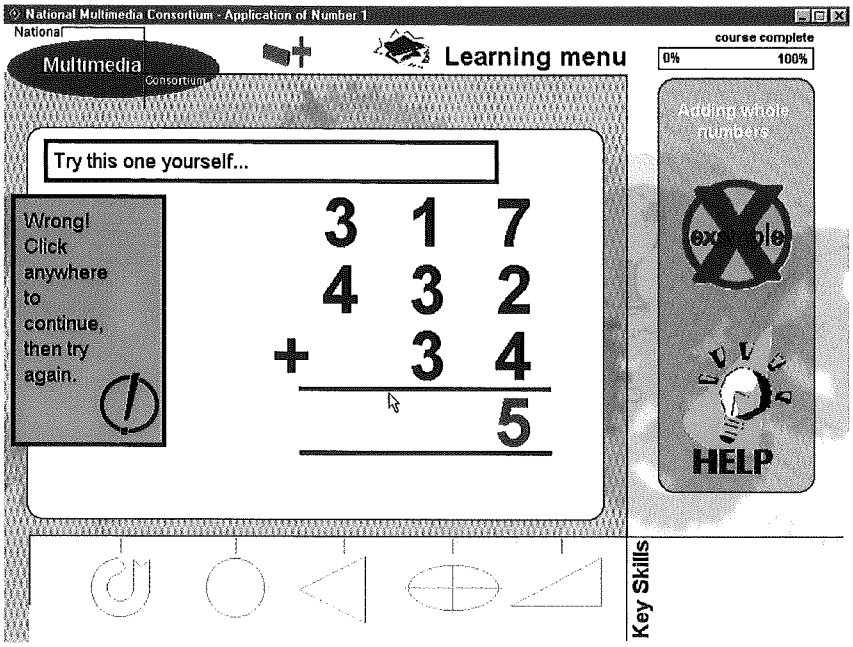



Figure A 22 Working through an example. Help is available only for those that want it.

# Appendix 27

## Examples of differentiation used in the final study

# Task screens

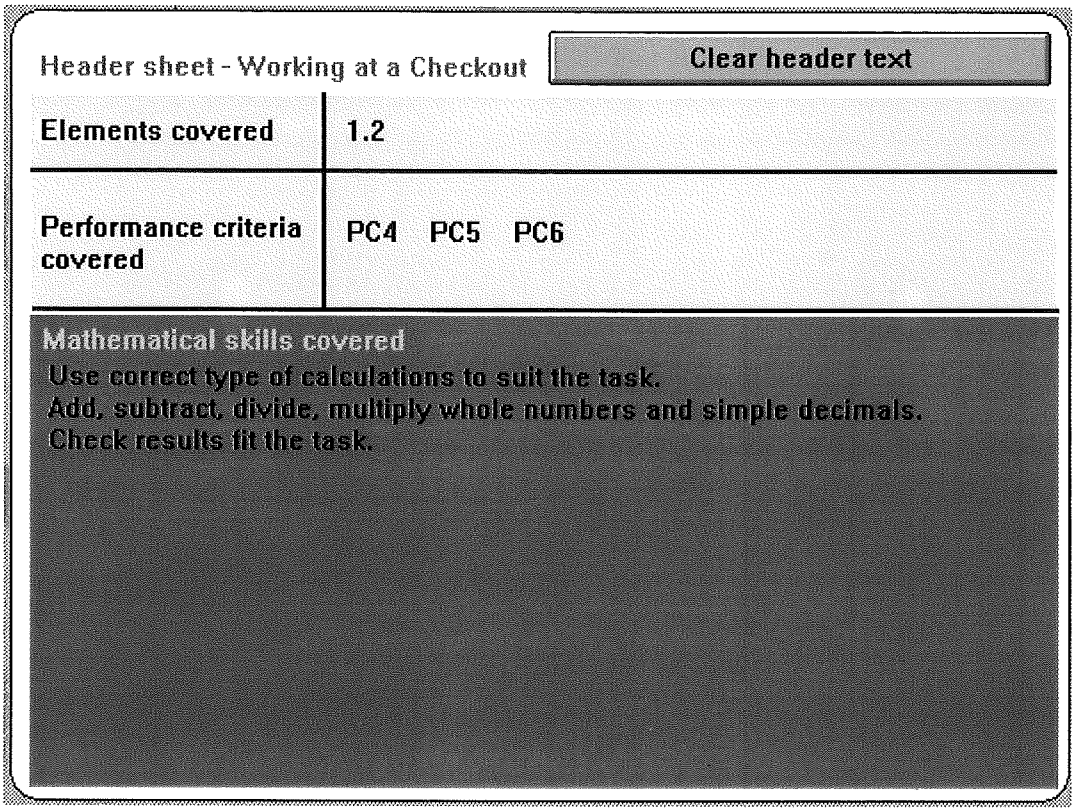
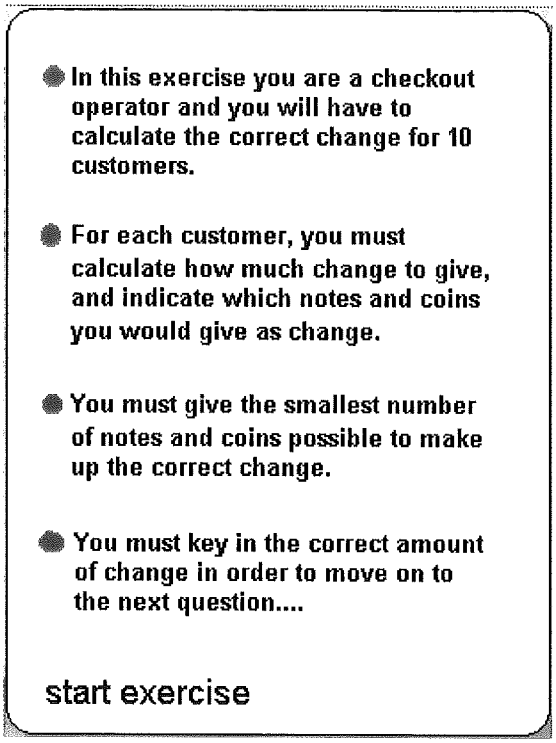



Figure A23 Level 1 task header screen.



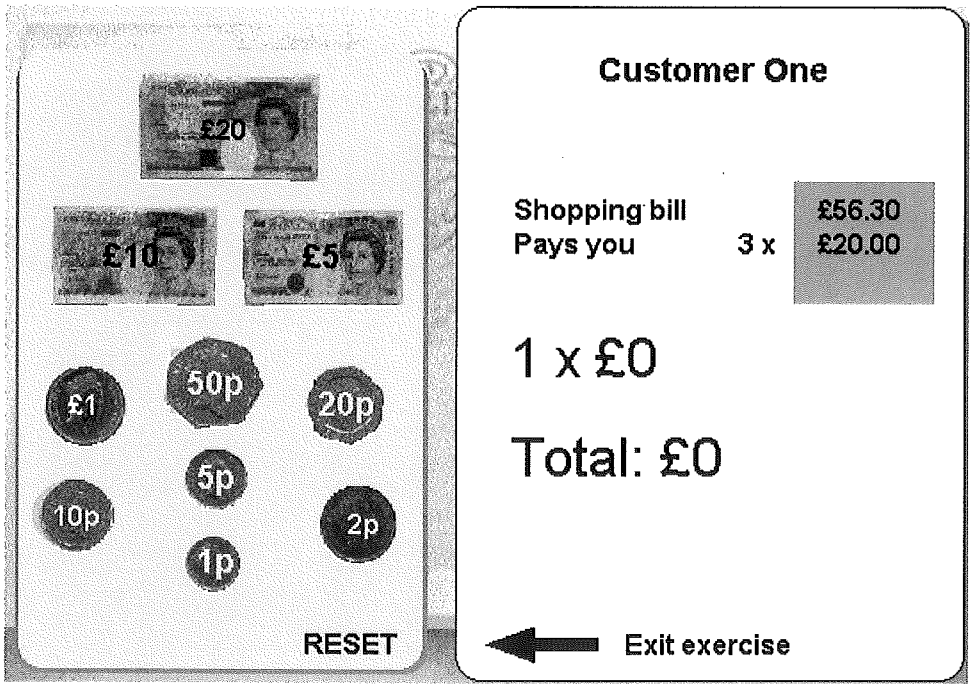
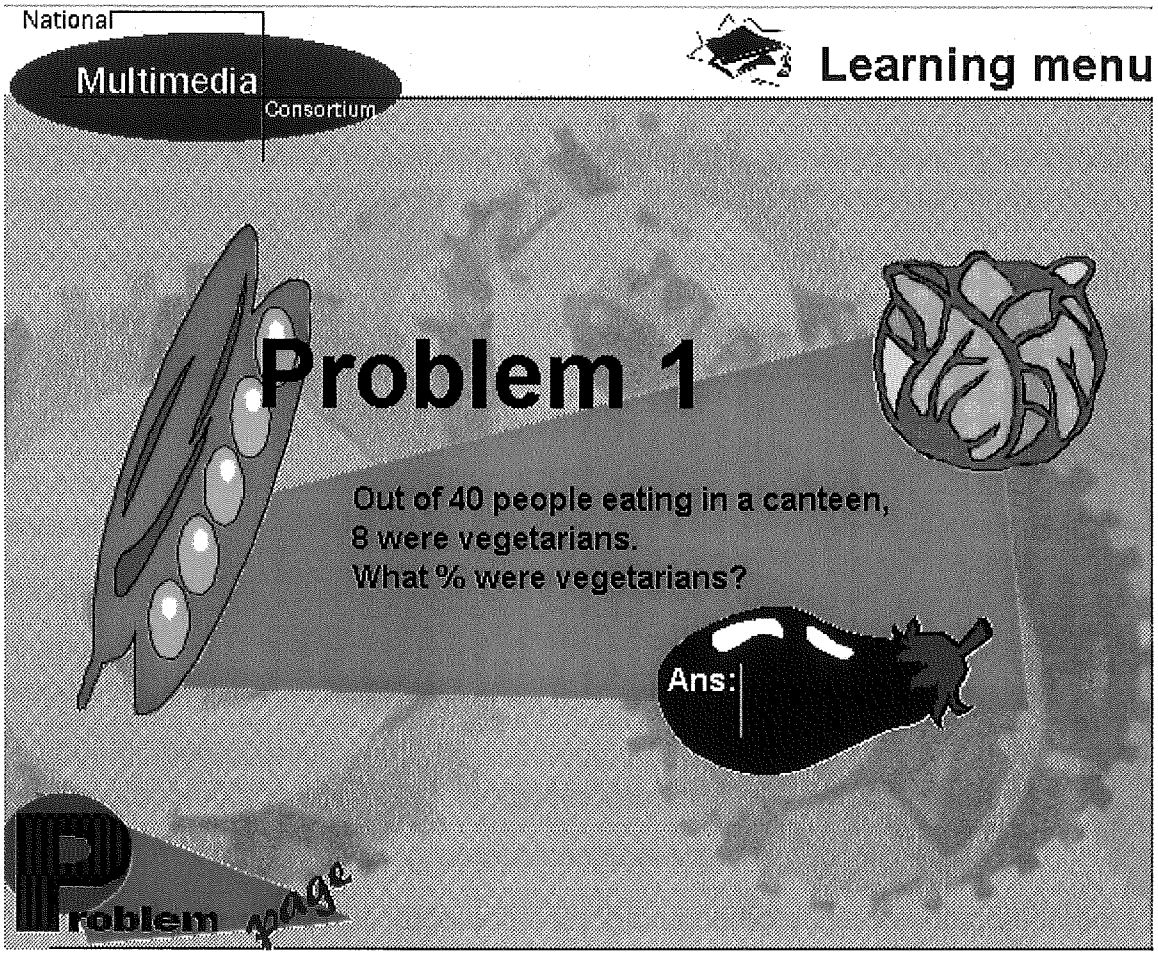




Figure A24 Level 1 task screen

## Questions

Figure A 25 Level 1 Question screen




**Level 2 questions. These are displayed in a similar format to the above question, or can be printed out.**

In a survey, the following record of people was obtained

| | |
|---|---|
| 12.00 | 15 people were already in the room |
| 12.05 | 5 people entered the room |
| 12.10 | 10 people entered the room and 5 people left |
| 12.15 | 4 people entered the room and 10 people left |

Find out the following information from the data

a) How many people were in the room at?
   i) 12.00
   ii) 12.05
   iii) 12.10
   iv) 12.15

b) How many people in all entered the room?

c) How many people in all left the room?

d) What was the percentage change in the number of people in the room at the following times?
   i) 12.00
   ii) 12.05
   iii) 12.10
   iv) 12.15

**Level 3 questions. These are displayed in a similar format to the above question, or can be printed out.**

In a survey, the following record of people was obtained

| | |
|---|---|
| 12.00 | 150 people were already in the room. |
| 12.05 | 10% of the people left the room. |
| 12.10 | 10 people entered the room and then 15% of the people left |
| 12.15 | 10 people entered the room and 25 people left |

Find out the following information from the data given

a) Answer the following questions
   i) How many people left the room at 12.10
   ii) How many people were in the room at 12.15
   iii) 12.10
   iv) 12.15

b) How many people in all entered the room?

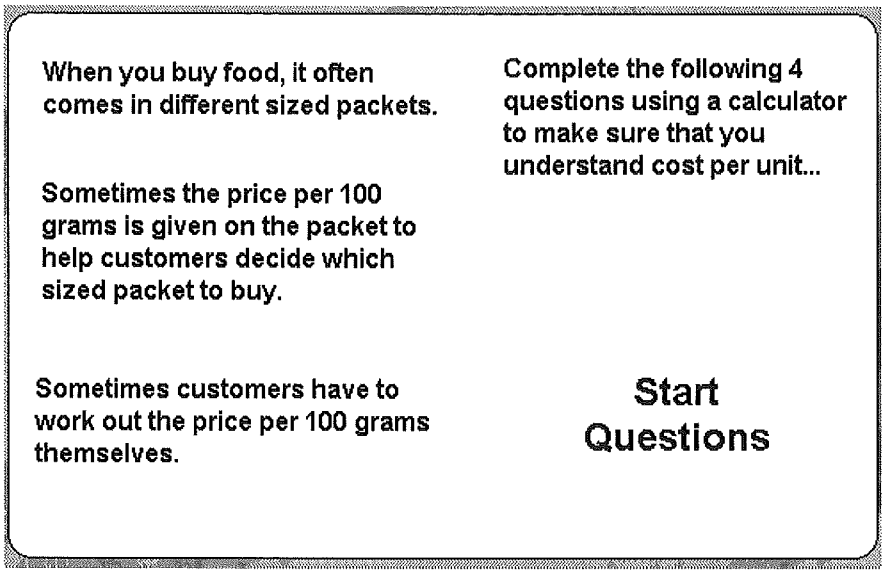
c) How many people in all left the room?

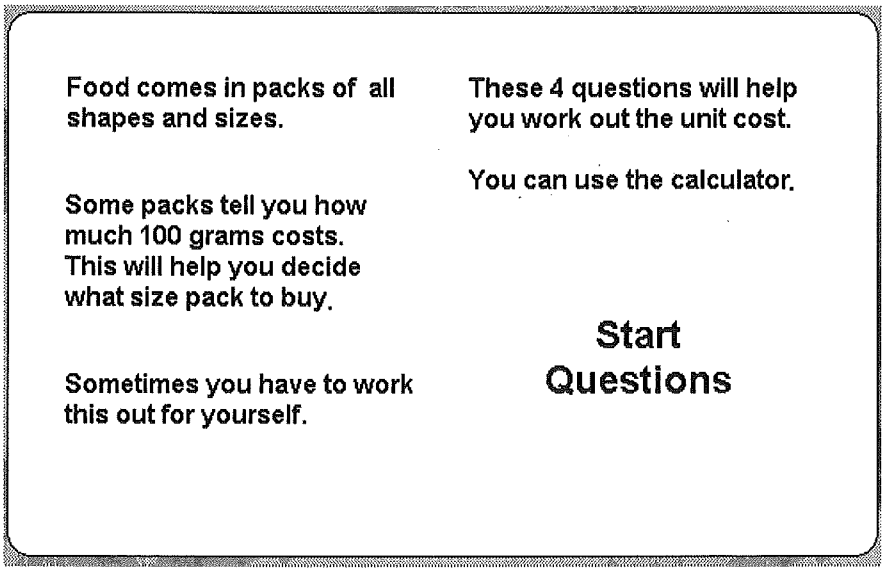
d) What was the percentage change in the number of people in the room at the following times?

   i) 12.00
   ii) 12.05
   iii) 12.10
   iv) 12.15

# Language

## High-level example




## Low-level example

Figure A26 High and low-level language screens

# Help and scaffolding levels.

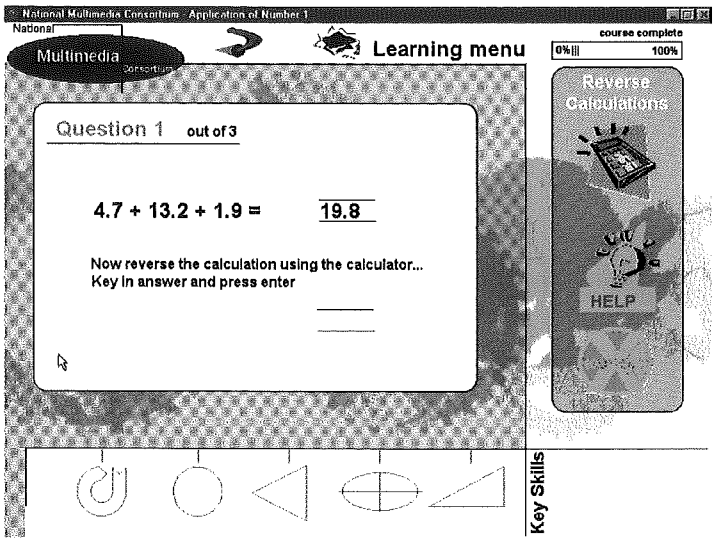



Figure A 27 Level 1 help screen.

Note that the help icon and the example icon are greyed out. A wrong answer will bring up a pre-determined help and advice sequence automatically.

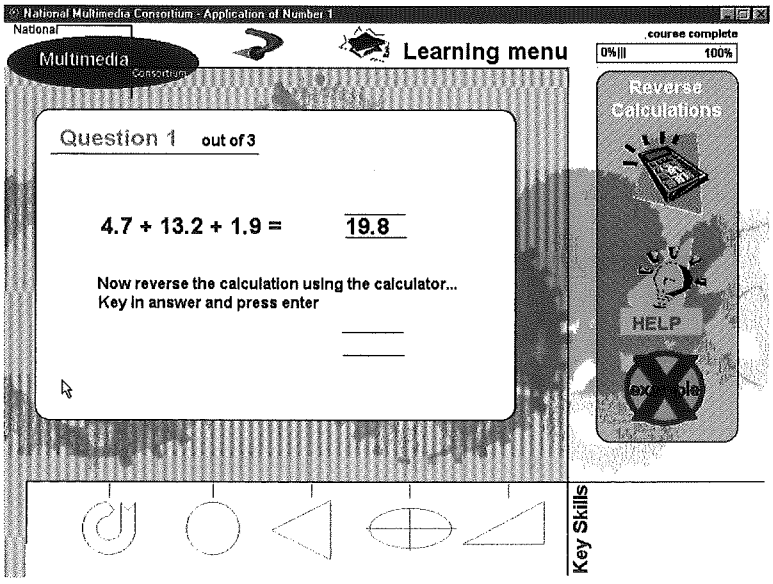



Figure A 28 Level 2 help screen.

Note that the help icon and the example icon are greyed out. A wrong answer will bring up help and advice automatically, but learners can request an example

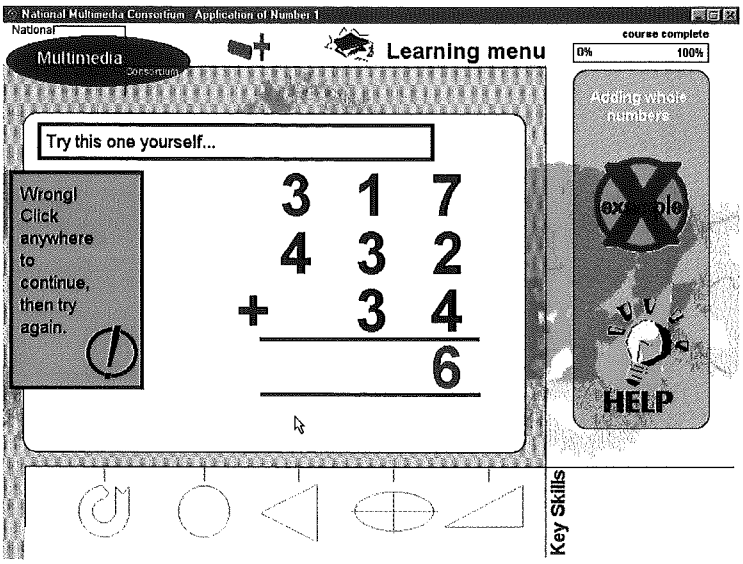



Figure A 29 Level 3 help screen.

Note that the help icon and the example icon are active No help and advice or examples are provided unless requested.

# Publications and Presentations

(Please see page xx)

# Contents

**Title:** **The creation of task-based differentiated learning materials for students with learning difficulties and/or disabilities.**

Full paper: Presented at CAL97 University of Exeter, March 1997

Keywords: Multimedia, Pedagogy, Teaching/learning strategies, Access issues, Further/vocational

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**Abstract:**

Horizon is a European funded project whose aim is to increase employment opportunities for students with disabilities or learning difficulties. A working cafe / restaurant (Cafe Horizon) has been established in East London, staffed by students involved in this project. Part of the project involved the creation of multimedia units, linked directly to Level 1 NVQ Catering and Business Studies, to support the training of the Cafe Horizon workers. One challenge of this work was to produce learning material that could be configured for the cafe worker in respect of their particular individual learning problems. To this end, a measure of differentiation was achieved in some learning units based on language level of the learner and subject level of the delivery. This paper describes the ways in which tasks are used within some of the multimedia applications to provide differential challenges for Cafe Horizon workers. Future work is planned where the individual learning style of the Cafe Horizon workers is considered.

## 1 Introduction

The aim of the Horizon project is to increase employment opportunities for students with disabilities or learning difficulties by providing appropriate training and work experience based in Cafe Horizon. Cafe Horizon workers attend Waltham Forest College one day each week where they work towards their NVQ in Catering. The Horizon multimedia materials form the basis of this work. Learners work individually or in small groups with specialist support workers who assist users and also participate in a situated evaluation of the software. Horizon learners are fully integrated with other learners in College open access IT centres using standard multimedia computers that have been slightly modified, for example, with touch screens. Other groups pilot the software at Waltham Forest Disability Resource Centre and at Hereford and Worcester Training Enterprise Council (HAWTEC). The installation, maintenance and evaluation of software at all locations is centrally co-ordinated by Waltham Forest College.

Students with learning difficulties and disabilities constitute a wide range of students who require varying additional support in their learning. Some students on the Cafe Horizon project have severe physical disability, yet in all other ways cannot be distinguished from other learners. Other Cafe Horizon workers have emotional and cognitive problems that impose severe restrictions on learning. Some have a combination of physical and mental disability in addition to problems of language.

All learners follow the same core course material, related to NVQ Level 1 Catering and Business Studies. It is important that this material is interesting and challenging to all learners and that all users derive some benefit from its use. An underlying theme in the production of multimedia support for these courses is
therefore the need to create material which is individually configurable for the learner.

## 2 Differentiation and configuration of learning materials

The differential presentation of learning materials and configuration of such materials to the needs of different users has been considered by a number of authors. For example, Riding has looked at the presentation of learning for learners with differing learning styles (see, for example, Riding 1996). Others have also related performance on learning applications to performance of learning style tests (Freeman 1996). Issues as to the configuration of learning applications have been approached in several different ways. Lanzing, for example, looked at preferred learning styles in relation to text or image based presentations (Lanzing 1994) and suggested three alternative approaches to tailoring presentations to a learner's individual needs:

- provide support for text and visual presentation modes, making learning as easy as possible for all learners
- use the single mode that best fits the learner's individual situation
- use only one mode, and not necessarily the mode that supports the learner best, arguing that this would reduce stimulation to the learner

In the Horizon project, it was decided to attempt a combination of these three approaches in order to support a wide range of learners. Examples of the way in which multimedia Horizon materials could be configured are given in section 4.

## 3 Underlying pedagogy - use of task-based materials

In the early days, behaviourist theories of learning were applied in the design of computer based instruction. In more recent times, authors have been keen to apply cognitive theories of learning to the design of such applications. The justification for this change relates to a paradigm shift in our understanding of learning that took place in the late 1960s and 1970s. Patrick (1992) has summarised many of the developments that have led to many of these changes.

Cognitive theories are concerned with the underlying thought processes that take place when people learn (Atkins 1993). According to cognitive theories, learners are expected to build their own hypotheses and explanations based on their learning experiences. Participation in active learning tasks is seen to be important in developing such constructs.

Tasks provide a means of engaging student's attention, and users of computer-based instruction packages are therefore commonly required to interact with the material. Frequent decision points are important as are games and simulations in which the results of decisions can be immediately seen (Atkins 1993). It has been suggested that the task of building computer models may provide direct support for the construction of mental models (Wild 1996), and Khan and Yip see tasks involving free exploration and self-directed learning as important for the testing of such models. Khan and Yip

suggest that for maximum effectiveness, task-centred instruction should be situated in tasks where knowledge is normally applied (Khan and Yip 1996).

The use of tasks to develop higher level cognitive skills in learning has been considered in the classroom by Felder and Brent (Felder et al 1994). Passive learning and an algorithmic approach to problem solving were cited as the among the reasons for high drop-out rates in science courses. In-class exercises investigated as an alternative approach included recall, stage setting and problem solving, and provide inspiration for the development of tasks for incorporation in multimedia learning packages.

## 4 Design of multimedia materials

Material for the Horizon project has been developed with all of the above points in mind. The aim has been to provide multimedia learning materials which support task-based learning at a range of different levels and using a variety of presentation modes so that the system can be configured to meet the individual needs of students with learning difficulties or disabilities.

Material is produced by teams of domain experts and educationalists, special support workers and technical experts. The detailed process used to design multimedia material for the Horizon project is described elsewhere (Barker et al in press), but in general terms, it is the responsibility of the subject specialist to ensure that the content of the material and built-in assessment satisfies the accreditation criteria for the award of National Vocational Qualification (NVQ), while the implementation of the material and the application of the pedagogical principles employed in its design is the responsibility of the project manager. The requirement to provide a single piece of multimedia learning material suitable for students with a wide range of learning and physical disabilities presents many problems. Not least it must challenge the most able and yet be useful to all learners and deliver learning to those with severe learning difficulties. In order to achieve this, a set of guidelines regarding the design of multimedia learning materials was established for use in the implementation of the project (Barker et al in press). Central to these guidelines was the concept of individual configuration to a particular user's needs. Each user has a unique configuration file that is read when the user logs in by selecting their picture from a login screen. The contents of this file are used to set up the level of language used in the course presentation, the configuration of sound presentation (on, off, interruptable, repeatable), the availability of additional help tools, text and screen presentation and the types and level of task available within the course.

The use of task-based learning is central to the design of the course. To incorporate suitable tasks, we have found a simple presentation model which is able to challenge some users yet not discourage others. For each screen of information presented, there is an associated set of tasks, a set of questions and a review screen. In this way simple material may be presented which is suitable for all learners, and additional challenges for some learners may be imposed by the selection of higher level language in the presentation and by the use of higher level tasks.

As an example, we may consider the presentation of information about cleaning agents. In this case, the information is shown on one simple screen, and three levels of task are available for the user in relation to this information. Tasks at different levels are defined in relation to Bloom's taxonomy of learning levels (Bloom 1956) in which the first three levels are:

Level 1 - Knowledge: Fact recall with no real understanding
Level 2 - Comprehension: Ability to grasp the meaning of material
Level 3 - Application: Ability to use learned material in new situations.

Level 1 tasks thus involve simple reproduction of the knowledge presented, for example, identifying which of the displayed cleaning materials could be used to clean a floor. Greater challenge is required to perform level two tasks. Comprehension of the material is needed, involving translation, interpretation and extrapolation according to Bloom (1956). For example a level 2 task might be to select from a range of possible scenarios (presented on video), the likely consequences of some action such as leaving a spill not cleaned up. Level 3 tasks involve the application of knowledge to practical situations. For example the learner may have to decide how previously presented information might be applied to their own particular work situation.

Tasks are implemented in several ways within the application. Simple tasks may involve pointing and clicking (or touching the screen), dragging and dropping and similar computer mediated activities. More complex tasks often involve thinking time, group activities away from the computer and involvement of tutors and work supervisors. The design of tasks is in itself a challenging activity and requires a high degree of effort and skill from within the team.

## 5 Discussion

The materials described above are currently being used by people with learning disabilities in England, Spain and Ireland and feedback from initial evaluations has been very positive. It is intended to produce German, Danish, Italian and other language versions when evaluation of stage one of the project is complete.

The use of tasks in multimedia learning applications is in many ways no different from their use in good classroom teaching. In both cases, they may be used to support learning by reinforcing learner's knowledge and by providing challenges where knowledge can be applied and understanding tested. In multimedia applications tasks are essential because they can add interest to the presentation and add realism, simulation and application to the learning process. The use of tasks for learners with severe physical and learning problems is especially important as it allows us to provide a high degree of support for all learners following the core material, yet differentiate to provide challenges for those learners in a position to make use of them.

Future work will look at extending the levels and types of task available to the learner. In addition it will be important to increase the number of ways that

learning material may be configured for the learner, perhaps on the basis of the individual learning style of the user. The importance of individual learning style has been emphasised by several authors, (Kolb 1978, Riding 1991, Riding et al 1996, Entwistle 1992), and it seems likely that the learning experience people with learning disabilities could be substantially improved by understanding their individual learning styles.

Finally, it is also important that individual methods of user evaluation are designed for use in this work. We have found that individual configuration of computer-based applications for learners with severe learning problems presents real challenges, not only in design and development, but also in the testing and evaluation of the material produced.

## 6 References


Atkins M J (1993) Theories of learning and multimedia applications. An overview: Research Papers in Education Vol 8 No. 2 1993

Bloom B. S., (1956), Taxonomy of Educational Objectives. Book 1 Cognitive Domain, David McKay Company, Inc. New York.

Cummings G, (1993), A perspective on learning for education systems, Journal of Computer Assisted Learning 9, 229-238

Entwistle N J (1988), Motivational factors in students approach to learning, In: Learning strategies and learning styles (ed. R R Schmeck), 21-51, Plenum Press, NY.

Felder R M (1993), Reaching the Second Tier - Learning and Teaching in College Science Education, JCST March April 1993. 286-290

Felder R.M., Brent R., (1994), Cooperative Learning in Technical Courses: Procedures, Pitfalls and Payoffs NSFDUE Grant DUE- 9354379 October 1994.

M. Freeman, (1996) 'Supporting Student Acquisition of Theoretical Material via Web Based Learning', in Proceedings of the 4th Annual Conference on the Teaching of Computing, August 27 - 30, 1996, Dublin, Ireland, R. O'Connor and S. Alexander (eds), published by Centre for Teaching Computing, Dublin City University, Dublin 9, Ireland.

Khan T, and Yip YJ. (1996), Pedagogical principles of case based CAL. Journal of Computer Assisted Learning, 12(3), 172-192

Kolb D, (1976), The Learning Style Inventory: Technical Manual, Boston: McBer and Co.

Lanzing J W A and Stanchev I, (1994), Visual aspects of courseware engineering, Journal of Computer Assisted Learning 10(2) 69-80.

Patrick J, (1992) Training, Research and Practice, Academic Press.

Riding R J, and Cheema I, (1991) Cognitive styles, an overview and integration, Educational Psychology, 11, 193-215, 1991

Riding RJ, and Read G. (1996) Cognitive Style and Pupil Learning Preferences, Educational Psychology, Vol. 16, 1, 1996 81-106

Wild M, (1996), Mental models and computer modelling, Journal of Computer Assisted Learning, 12(1) 10-21.

# Evaluation of Horizon Multimedia Learning Materials for Students with Learning Difficulties and Disabilities

**Keywords:** Multimedia, Evaluation methods, Individual configuration, Access issues, Further/vocational

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## Abstract

Horizon is a European funded project whose aim is to increase employment opportunities for students with disabilities or learning difficulties. A working cafe/ restaurant (Cafe Horizon) has been established in East London, staffed by students involved in this project. Similar initiatives are taking place at other locations in this country and in Ireland and Spain. Part of the project involved the creation of multimedia units, linked directly to Level 1 National Vocational Qualifications (NVQ) in Catering and Business Studies, to support the training of these workers. In this paper we describe the design of a practical approach to evaluating individually configurable multimedia materials developed for the Horizon project. These materials were created according to constructivist theories of learning using a simple student model to hold user information. In this way, individual configuration of learning was achieved. Evaluation objectives were established early in the project cycle. These were closely related to the working environment and to individual learning objectives set for each learner. Five methods used for formative and summative evaluations in the project are described and some benefits and limitations of each method are presented.

## Introduction

Horizon is a European project, the aim of which is to increase employment opportunities for students with disabilities and learning difficulties. In Ireland, Horizon workers run a public house, in Spain a restaurant and in the UK, a small cafe, Cafe Horizon. Multimedia learning materials have been developed to provide a supported learning environment that forms the basis of training for this work. Cafe Horizon workers attend Waltham Forest College one day each week where they work towards their Foundation Level National Vocational Qualification (NVQ) in Catering, using the multimedia materials in college learning centres. Materials are also being used in Ireland and Spain in similar ways.

Horizon workers constitute a wide range of learners who require varying additional support. Some have severe physical disability, yet in all other ways cannot be distinguished from other learners. Other Cafe Horizon workers have emotional and cognitive problems that impose severe restrictions on learning. Some have a combination of physical and mental disability in addition to problems of language. One challenge of this work was to produce learning material that could be configured for the learner in respect of their particular individual learning problems.

## Individual configuration of learning - a simple student model

Many authors hold that constructivist theories of learning should underpin the development of learning applications, for example, Park and Hannafin (1993) and Atkins (1993) describe such an approach. To assist in this process, information on the learner may be held in the form of a student model which is a representation of the learner's knowledge, prior skills and characteristics used to configure a computer learning application (Muldner et al, 1997).

A simple student model is used in the Horizon project, where a configuration file is used to individualize applications for learners. Computer based diagnostic tests are used in conjunction with specialist tutors to configure this file. The components of the student model are briefly described below.

**Components of the student model**

- **Domain level:** Previous subject ability is measured by a simple pre-test.
- **Language support:** Material is presented at appropriate language level, based on the results of language pre-tests.
- **Learning style:** Material is presented according to learners' preferred learning style
- **Task Level:** Task levels are configured for individuals as described by Barker and colleagues (1997a) based on Bloom's taxonomy (Bloom 1956).
- **Questions:** In-course questions are used to challenge learners and provide feedback. The student model selects the level and type of question.
- **Interface configuration:** Information is held about special requirements of learners, for example the need for a touch screen, font size, sound setup and screen presentation.

The methods used in the design and development of Horizon materials have been described by Barker and colleagues (Barker et al, 1997b). Our approach to evaluating these materials is shown below.

**Evaluation of Horizon material.**
In this section we describe the objectives of our evaluation scheme and the various methods we used to achieve them.

Evaluation is important in all stages of the project life cycle according to Rushby (1997). Many authors have distinguished between summative and formative evaluation (Squires, 1996; Rushby, 1997). Formative evaluations are carried out throughout the development of the material and should involve designers, developers and a few learners according to Chanier (1996). Formative evaluation is used to guide the design and initial implementation of the package. Summative evaluation relates to the evaluation of the final application. Both formative and summative evaluations were used in the development of the Horizon materials.

Evaluation objectives were specified early in the project. In the next section we outline evaluation objectives in three related areas, pedagogy, usability and user satisfaction.

## Evaluation objectives

### 1. Assessment of Learning and Pedagogy

Yildiz and Atkins (1993) provide guidelines for the design of evaluation, based of a survey of evaluations since the 1970s. Park and Hannafin (1993) also provide a set of empirically derived guidelines for conducting evaluations, based on user interface and pedagogical principles. Learning is individualized in our project by the use of individual targets and objectives for each learner. These were used to establish a set of objectives upon which pedagogical evaluation was based. The following considerations were used to establish the evaluation objectives:

Were specific learning objectives supported by the application?
Were targets achieved or not?
Did material support constructivist learning?
Were applications interactive and task based?
Could learners contribute to their own learning?
Did computer system integrate well with other systems in place?
Were tutors involved in the course?
Was content accurate and appropriate?
Was course material, assessment, etc. at the appropriate level?
Was the use of the media appropriate or not?

### 2. Interface design / usability testing

The principles of interface design have been described by several authors, for example (Dix et al, 1994; Reeves and Harmon 1994). In our project the software had to be simple to use and had to perform efficiently and robustly, leading to the following usability considerations:

Could users start, login and logout of packages easily?
Were users with disability supported?
Were applications robust?
Was unnecessary cognitive overhead avoided?
Were instructions clear and easy to follow?
Could users navigate, locate and orientate easily?
Did users always know what to do next?
Were users able to perform required tasks easily?
Did learners have sufficient computer experience?

### 3. Interest and User Satisfaction

Our objectives in this area were simple:

Did learners like using the application?
What features of the course were judged to be good or bad?
Were screens clear and attractive?
Did applications have the right 'look' and 'feel'?

Were media of high quality and did they add to the course?
Were materials interesting or boring, interactive or passive?

An evaluation scheme based on the above was produced which had the following format:

- The objective to be tested
- How it is to be tested - evaluation methods and detailed procedure.
- When it should be tested (formative, summative) and by whom
- Assessment criteria for the objective

In the following section we describe the various methods we used to assess the material.

**Evaluation methods**

The following methods of evaluation were used in the project.

- Expert evaluation
- Analysis of logged data
- Questionnaire methods
- Interview methods
- Video methods

For each method we will describe how it was used, together with some of its benefits and limitations in the project.

**Expert evaluation**

The use of expert evaluators is described by Catenazzi and colleagues (1997), who took the role of less experienced users to identify usability problems. Expert evaluation has been described by Perisco (1996), who describes it as a form of subjective evaluation performed on prototypes. In the Horizon project, prototypes were distributed to subject, educational and learning difficulties specialist. Guidelines were developed at transnational meetings for use in these evaluations.

We found that experts were very efficient in unearthing problems, but that language translation took more time than was anticipated. The need for regular updating meetings between evaluators and developers increased costs. The use of learning difficulty specialists saved much trial and error, as they were able to identify and correct potential problems early in the development stage.

**Analysis of logged data**

The use of automated data collection methods has been described by Henderson and colleagues (1995), who state that the technique is unobtrusive, inexpensive, accurate and reliable. However, Laws and Barber found it difficult to gain high level insight from low level data capture methods

(Laws and Barber 1989). We collected full tracking information including login and logout times, times spent on each screen and navigation information from which it was hoped that high level user intentions might be inferred.

One important use of the method was the isolation of specific problem areas encountered by some learners. It was possible, for example, to identify learners who were moving through the course slowly from their log files. Potential reasons might include navigational, interface, domain, specific disability, language or other problems. It was then possible to use another method to identify the specific reason, for example interview or video. Logged data provided large amounts of information that was cheap to acquire yet expensive to process. Data files created were used for formative and summative evaluation and were useful for tutors to track learners' progress in a course. The method translated well for evaluating other language versions.

**Questionnaire methods**

The design and use of questionnaires has been described in many places in the literature. For example, Karat (1988) states that the method is inexpensive, fast and easy to process. However, Henderson and colleagues (1995) caution over the use of questionnaire data taken in isolation. Three types of questionnaire method were developed for summative and formative evaluation of the Horizon material.

- Paper based questionnaires were developed from the evaluation guidelines. A five-point scale was used to record information about user satisfaction, experiences and difficulties. Questionnaires were short and simple and were distributed widely for comment.

- Multimedia versions of questionnaires with sound support and simple graphical interface were developed.

- Group questionnaire methods were used to support learners with difficulty using questionnaires. Small groups of learners discussed and completed questionnaires together with their tutor at the end of each session.

Although questionnaires were related directly to our evaluation objectives, we found that the general nature of our questions made it difficult to identify specific problems. Sometimes attributes rated on questionnaires did not exist in the application, for example sound support was rated highly when not used. Sometimes learners clearly did not understand questions. The multimedia questionnaire was considered to be a good feature by experts and simplified marking. The group questionnaire method was introduced to enable learners with severe cognitive problems to contribute. It was more costly than simple questionnaire but provided information unobtainable elsewhere. Users were able to share experiences about the application with tutors and often this led to new information about the application. Videos of group sessions were found to be useful.

Questionnaires were helpful in finding out general attitudes but the individual nature of the Horizon material, the specific problems of learners and the small sample size, made individually completed questionnaires less useful than other methods. The group questionnaire method has potential for the future.

**Interview methods**

Interviews were used in the formative evaluation in the Horizon project. Cordingley (1989) describes the use of a semi structured interview method that we adopted for this work. Structured components of the interview consisted of about thirty or so questions and were scripted based on the evaluation objectives. Interviewers were fully briefed on the evaluation objectives and were present while learners were using the Horizon material. Subjects could respond in any way to questions and were encouraged to explore issues. Interviews were recorded unobtrusively on video for later viewing.

The open ended nature of the interview method used was important in locating problems that were missed by other methods. Interviews provided anecdotal information that was useful for developers. Video recording of sessions was useful as it recorded facial expressions and body gestures. The video recording did not appear to affect subjects, who were keen to participate. Interview methods are expensive and require effort to set up and process data. They did however provide large amounts of useful information

**Video methods**

Laws and Barber (1989) describe the use of video as a data capture method which they suggest is useful for collecting anecdotal evidence in addition to more structured data. The ability to view video repeatedly makes it more useful than simple observation. Video was used in two ways in our work. General information was provided by loosely structured video sessions with up to six learners at each session. Such sessions were scripted to record general features of applications. For example team working and interactions between learners and tutors were recorded.

More formally structured scripted video sessions were also performed. For example learners were asked to login, logout, locate specific areas, find information and perform tasks. Videos of these actions were viewed by the development team later.

The use of scripted video sessions was found to be efficient in the testing of problem areas identified by expert evaluation or other method. It was possible to test critical areas of courses and such information led to rapid improvements in interface design. Group sessions were less useful for locating specific problems in the applications, but provided useful summative information on how courses were being used and the learning environment. Video methods were found to be expensive, yet were able to provide detailed and useful information and videos could be viewed repeatedly.

## Discussion

The Horizon learning materials are currently being used to support training and work experience of six groups of learners in three countries. It is hoped to extend the project to include other European countries in the future. Several features of the project added to the difficulty of evaluation. These were: the requirement for rapid prototyping and material development, the learning difficulties dimension, the constructivist approach and need for individual configuration of learning, the transnational component and small scale of the project. Several authors have recommended that evaluation be situated in context (Squires and McDougall, 1996; Squires, 1997; Yildiz and Atkins, 1993). In our project, evaluation took place with real learners and experts using the material in real training and vocational settings.

A combination approach to evaluation was employed to overcome many of the above difficulties. All methods used in the project provided useful formative information for developers. We confirmed the findings of Henderson and colleagues (1993) that methods used in combination were better than any single method at identifying problems. This was especially true when methods were combined with expert evaluation.

The evaluation did not attempt to measure cost effectiveness or to compare multimedia with other methods of delivering learning. Reeves (1991) points out problems involved in this type of comparison. Summative evaluation therefore, centred on how useful the applications were in supporting learning.

Difficulties that arose due to the dispersed nature of the project were helped by regular transnational meetings. These were found to be very important in the evaluation process. Not only did such meetings help in sharing objectives and ideas, but were also important in maintaining momentum and providing deadlines for evaluators.

## References


Atkins, M. J. (1993), Theories of learning and multimedia applications: An overview: *Research Papers in Education*, Vol. 8, No. 2.

Barker, T., Jones, S., Britton, C. and Messer, D.J. (1997a), The development of task based differentiated learning materials for students with learning difficulties and / or disabilities, *Proceedings of CAL-97 conference,* University of Exeter, March 1997.

Barker, T., Jones, S., Britton, C. and Messer, D.J. (1997b), Creating Multimedia Learning Applications in a Further Education Environment, *Technical Report No. 271*, University of Hertfordshire, Division of Computer Science, January 1997.

Bloom, B. S. (1956), *A Taxonomy of Educational Objectives,* McKay Company Inc.

Catenazzi, N., Aedo, I., Diaz, P. and Sommaruga, L. (1997), The evaluation of electronic book guidelines from two practical experiences, *Journal of Educational Multimedia and Hypermedia*, 6(1), 91-114.

Chanier, T. (1996), Evaluation in a project life cycle, *Association for Learning Technology Journal*, Volume 4, Number 3.

Cordingley, E. S. (1989), Knowledge elicitation techniques for knowledge based systems, In: Diaper D., (ed) *Knowledge elicitation: Principles, Techniques and Applications,* Ellis Horwood.

Dix, A., Finlay, J. and Beadle, R. (1994), Usability Paradigms and Principles, *Human Computer Interaction*, Prentice Hall.

Henderson, R., Podd, J., Smith, M. and Valara-Alvarez, H. (1995), An examination of four user-based software evaluation methods, *Interacting with Computers*, 7(4), 412-432.

Karat, J., (1988), Software Evaluation Methodologies, In: Helander, M. (Ed.) *Handbook of Human Computer Interaction,* Elsevier.

Laws, J. V. and Barber, P. J. (1989), Video Analysis in Cognitive Ergonomics: a methodological perspective. *Ergonomics* 32(11), 1303-1318.

Muldner, T., Muldner, K. and van Veen, C. M. (1997), Experience from the design of an authoring environment, *Journal of Educational Multimedia and Hypermedia*, 6(1), 114-132.

Park, I. and Hannafin, M. (1993), Empirically based guidelines for the design of interactive multimedia, *Education Technology Research and Development,* 41, 63-85.

Perisco, D. (1996), Courseware validation: a case study, *Journal of Computer Assisted Learning*, Volume 12, Number 4.

Rushby, N. (1997), Quality criteria for multimedia, *Association for Learning Technology Journal*, Volume 5 (2), 18-30.

Reeves, T. C. (1991), Ten commandments for the evaluation of interactive multimedia in higher education, *Journal of Computing in Higher Education,* Volume 2 (2), 84-113.

Reeves, T. C. and Harmon, S. W. (1994), Systematic Evaluation Procedures for interactive Multimedia for Education and Training, Chapter 15 in*: Sorel Reisman, Multimedia Computing - preparing for the 21st Century,* Harrisburg (USA) and London (UK): Idea Group Publishing.

Squires, D. (1997), An heuristic approach to the evaluation of educational multimedia software, *Proceedings of CAL-97 conference*, University of Exeter, March 1997.

Squires, D. and McDougall, A. (1996), Software evaluation: a situated approach, *Journal of Computer Assisted Learning,* 12 (3), 146-161.

Yildiz, R. and Atkins, M. (1993), Evaluating Multimedia Applications, *Computers educ.,* 21(1/2), 133-139.

# Creating Horizon multimedia learning applications to support students with learning difficulties and disabilities

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**Abstract**

Horizon is a European funded project whose aim is to enhance employment opportunities for students with disabilities or learning difficulties. A working cafe-restaurant (Cafe Horizon) has been established in East London, staffed by students involved in this project. Part of the project involved the creation of multimedia units, linked directly to Level 1 NVQ Catering and Business studies, to support the training of Cafe Horizon workers. This paper describes the complex process of producing learning materials for the Horizon project and the lessons learnt that are applicable to the development of multimedia learning applications in general.

**Conference theme**

CIT and new goals, contents and methods

**Keywords**

multimedia, learning applications, learning difficulties and disability, development process, evaluation

## 1 INTRODUCTION

Waltham Forest College have established a Learning Materials Development Unit whose function is to create multimedia learning materials for use within the College as well as for use outside. The complex process of multimedia design has been described by several authors; for example Howles and Pentergill describe a simplified seven step process for producing multimedia (Howles et. al., 1993). Others suggest that the process is more complex than the seven steps described . McAteer and Shaw, for example, describe a fuller system for planning, developing and testing multimedia materials within a Higher Education context. (McAteer et. al., 1994). Arnold and colleagues also describe the construction and implementation of multimedia teaching packages in a Higher Education environment. (Arnold et. al., 1995). Allessi and Trollip have looked in detail at areas of Computer Based Instruction (CBI), including preparation, design, flowcharting, storyboarding and evaluation of materials. (Allessi et. al., 1991).

Britton and colleagues looked at current practice in twenty three commercial organisations producing multimedia They found that team sizes were between 2 and 10 people and that subject experts were represented on approximately two thirds of teams. Seventeen of the twenty three organisations employed teams of five or fewer people. They identified several features of the design process that differed considerably from the development of traditional software systems. (Britton et. al., 1996). It is evident from this and other work that guidelines for multimedia development need be considered very much in the context of the development environment, and that many reports in the literature, although sound in theory, do not reflect what actually takes place.

The work of Britton and experience at Waltham Forest College show that many authors use their own in-house methods of learning materials production. In Further Education today there is a great need for high quality multimedia learning materials and staff in colleges are creating such material, often with small budgets and demanding time constraints. The composition of production teams and the types of skills brought to the team, are likely to be variable from college to college.

In the absence of universally applicable guidelines for this work, it is important that there are many examples of current practice available for others to share although commercial interests may prevent some authors from sharing their experiences and what they have learnt. In this paper we describe the development process for multimedia learning materials. Those parts of the process that were problematic are emphasised as are those that worked well.

General points made are illustrated with examples from the Horizon project. Horizon is a European funded project whose aim is to enhance employment opportunities for students with disabilities and/or learning difficulties. A working cafe-restaurant (Cafe Horizon) has been established in East London, staffed by students involved in this project.

## 2 HORIZON: AN EXAMPLE OF THE MULTIMEDIA DEVELOPMENT PROCESS AT WALTHAM FOREST COLLEGE

At Waltham Forest College multimedia learning material is produced using a standard methodology which has been developed over the last four years within the unit. There are several additional complications, however, involved in the creation of Horizon materials:

- There is a large specialist component in terms of learning difficulties and disabilities.
- There is the need to produce foreign language versions
- There is a requirement for extensive international use of the material. This involves transnational meetings between the software design team and partners with additional issues relating to distribution, installation and evaluation of the software.

The following headings outline how materials are produced within the unit:

- formal proposal and needs analysis;
- development team formed;
- subject specialist specifies material for inclusion in course;
- material passed to learning difficulties and disability (ld&d) specialists;
- material passed to the production team who storyboard the material for multimedia production;

- material modified for interactive presentation
- story board / specification discussed and modified
- design / layout specialists involved;
- creation of the media;
- material produced as prototype (foreign language versions produced);
- material tested against technical standards;
- material evaluated by users and experts according to specific requirements;
- final versions produced;
- evaluation of the material;
- results fed back into later work.

## 3 FORMAL PROPOSAL AND NEEDS ANALYSIS

All multimedia learning material projects start from a formal project proposal which will include a needs analysis. Formal proposals are usually generated by subject specialists in collaboration with the project manager. In the case of the Horizon project this process was complicated by the need to integrate the multimedia proposal into a much larger structure, involving transnational partners and specialists in several areas. Subject, LD&D and technical specialists were involved in creating the formal proposal for the Horizon project.

## 4 DEVELOPMENT TEAM FORMED

The standard project team is comprised of:

- subject specialist team;
- project manager;
- computer support staff;
- programmers;
- graphic designers;
- other specialists (language, learning difficulties, educationalists etc.).

Often team members may take on more than a single role and in larger projects several persons may undertake a single function, for example in the Horizon project there were two or sometimes more programmers and several subject experts. Depending on the stage of the project, some members are required less and others more. The role of the multimedia project manager is to ensure that the team members achieve their actions by the required deadlines and to keep the whole complex process on line.

The project manager will assist in setting partial objectives and deadlines which must be by agreement. The project must be fully documented at all stages of the process. In the Horizon project, the multimedia project manager has a place on the project steering group. This role is important especially in large projects such as Horizon where good communication within and between teams is essential.

## 5 SUBJECT SPECIALIST SPECIFIES MATERIAL FOR INCLUSION IN COURSE

It is important that the subject expert is at the centre of the development process at this stage of a project. In the Horizon project, course material is based on NVQ Level 1 Catering and Business Studies. The software specification includes *the underpinning knowledge* which is linked to specific learning objectives for the NVQs. Catering and Business Studies tutors are therefore responsible for the initial specification of this material. Additionally Learning Difficulties specialists work closely with subject specialists from very the beginning.

It is important at this stage that subject specialists understand the needs of the programmers and designers. It is our experience that subject specialists learn the special skills required for multimedia authoring as they

become more involved in the team. There is also support provided in the form of formal and informal training events for subject authors.

## 6 MATERIAL PASSED TO LEARNING DIFFICULTIES AND DISABILITY (LD&D) SPECIALISTS.

All multimedia learning materials need to be assessed by LD&D specialists. This is an important stage in the development of the Horizon material and usually requires re-writing. There may be several specialists involved in this process. Learning difficulties and disability specialists work closely with subject specialists from the beginning and throughout the project, to make sure that important elements related to their specialism are considered from the start.

## 7 MATERIAL PASSED PRODUCTION TEAM WHO STORYBOARD THE MATERIAL FOR MULTIMEDIA PRODUCTION

The storyboarding process has been described by several authors, (McAteer et. al., 1994, Allessi et. al., 1991). These describe a common representation of the storyboard as a succession of thumbnail sketches or cartoons. This is often the case within our own projects, but on occasions other methods are used, including fairly detailed written descriptions and flow diagrams. The term storyboard is often used in house to apply to the formal software specification at this stage.

What we consider important at this stage is to create the representation of an underlying structure for the course which can be understood by all the team. Structures may be linear or non-linear, differentiated or non-differentiated, interactive or passive. A final structure for the material is the end result of a long process involving many discussions between team members. Compromises are usually made, as the proposed structure will be influenced by the pedagogy, learning theories employed by the subject specialists and the learning objectives. Choice of authoring software is normally made at this stage. Templates, (sections of bare code to which text, graphics and other media can be added), are used in the development of courses if possible. The benefits of templates include speed of production, application of house style to new work and re-use of good ideas without duplication of effort. In the Horizon project templates were used extensively in the creation of material.

For the Horizon work, the following guidelines were developed for the material.

- content of the material to be determined by the subject specialist;
- learning objectives to be specified by subject specialists;
- differentiated paths available within the material to include:
    - language support (and diagnostic);
    - extra subject support available;
    - fast routes through the material;
    - tasks provided at a range of levels.
- simple visual log in procedure (see figure 1);
- simple navigation and orientation tools (see figure 2);
- specific learning difficulties and disability (ld&d) support considered;
- touch screen technology catered for;
- hierarchical structure with simple navigational and orientation tools included;
- high design quality of images (see figure 3);
- clear text, bold, simple fonts, simple colours (see figure 4);
- a mixture of realism and cartoon to be used, producing an entertaining presentation;
- amount of information presented on the screen at any time to be limited and able to be controlled;
- screens to include delivery of information, interactive tasks, questions;
- review screen;
- hypertext glossary and help systems to be built in;
- use of video animation to add interest and extra realism;

- sound options configurable by user / tutor;
- standard user interfaces with student recording built in;
- individual user configuration files;
- assessment and accreditation should be built in.

A stated intention was to produce material that could be configured for the specific needs of the individual user. It was intended that the material would challenge the more able, yet support those with severe learning difficulties. The creation of task-based differentiated learning materials for students with learning difficulties and/or disabilities has been described by Barker and colleagues. (Barker T 1997).

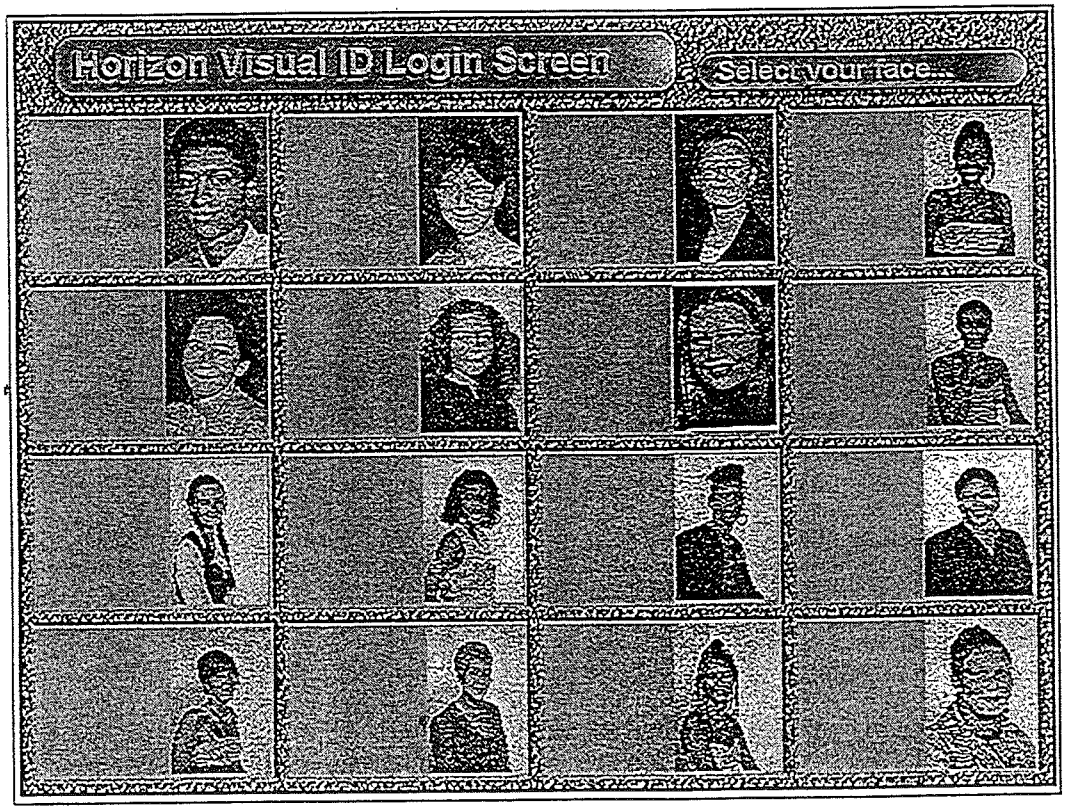


Figure 1 Horizon Visual ID Login Screen

Students log in to the system by selecting their face or picture from the image of their group. The user picture file can hold up to 16 users and is accessed from the local hard drive to enable it to be modified easily.

A simple navigational and orientation tool is provided as shown in figure 2. The user can navigate to areas of the course by selecting from the map. Places already visited have a small grey icon drawn on them. Their present location in the course has a larger figure displayed. Students soon learn to use the map to see where they've been and where they have yet to go.

A simple presentation screen is displayed in Figure 3. Users may move to the next screen using the forward arrow button. Clicking the repeat sound button will play the sound again. Text is displayed clearly and boldly in a simple font. The amount of information displayed on the screen at any one time is limited.

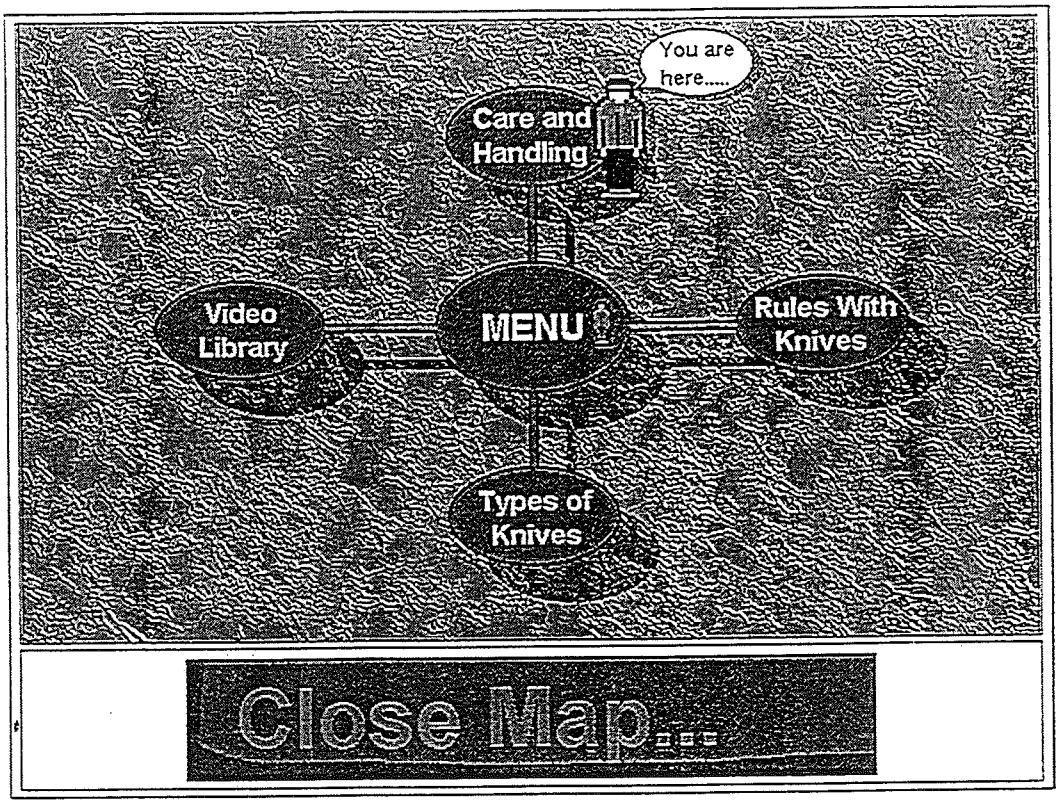


Figure 2 Navigation and orientation tool

In Figure 4 a screen presents instructions for performing a task away from the computer. It enables the student to print out material necessary for doing the task.

## 8 MATERIAL MODIFIED FOR INTERACTIVE PRESENTATION

Once a storyboard/specification has been developed, the team look again at the material for the course and modify it in the light of the storyboard. The script for the material is generated at this stage and interactivity issues considered. It is vital that the designers and programmers are able to communicate their ideas to subject specialists at this stage. The use of small prototypes and dummy displays to illustrate ideas is useful here. All team members are present at these meetings as far as possible.

## 9 STORY BOARD / SPECIFICATION DISCUSSED AND MODIFIED

In a cyclic process of discussion and modification a final version of the storyboard is created. This will specify the following:

- all learning objectives and the learning material specified to underpin them;
- full script for the material;
- all assessments and interactive tasks;
- overall structure of the course;
- orientation, navigation tools to be used;
- issues of linearity, differentiation and interaction;

- pedagogical factors linked to presentation;
- ld&d factors taken into account;
- draft screen design and layouts;
- text, sound and video files to be created and their location in the course;
- additional support required (for example language);
- student recording and tracking details;
- authoring software.


Figure 3 Presentation Screen

## 10 DESIGN / LAYOUT SPECIALISTS INVOLVED

Initial ideas about screen design and layout are put into effect. The whole team is involved in modifying screen design at all stages of a project. It is important that design specialists are used to create high quality screen layouts. It is also important however that the whole team is involved in the look and feel of the presentation. The team considers the level of the material being created and its use. This information is fed back to designers at this stage. In the Horizon project, learning difficulties experts are involved. The user interface is specified. For the Horizon project several issues were felt to be important. Naturally the interface had to be simple yet interesting for users. It was also important not to impose additional burdens on the user for example by poor choice of screen layout, colour, size of hotspots, speed and many other factors. The use of small prototypes, (often only one or two screens) was essential here.

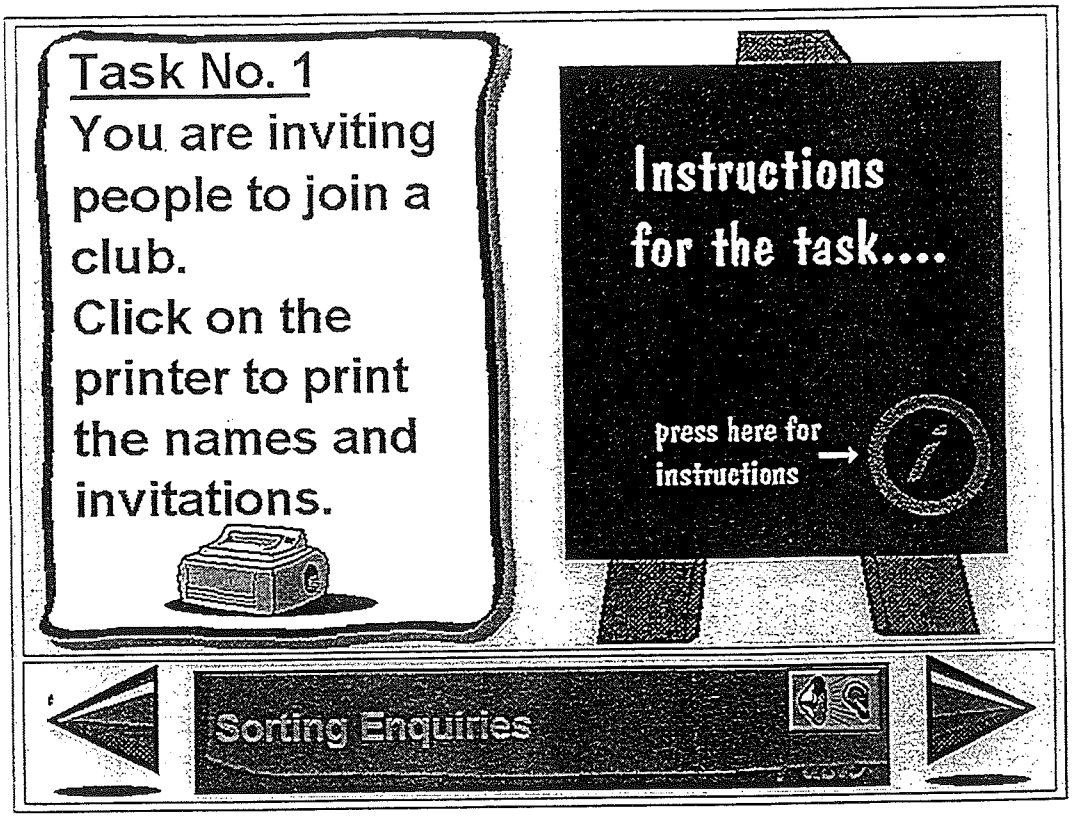


Figure 4 A Task Screen

## 11 MEDIA CREATED

The text, images, sound, animation and video files for the course are created. The format of the media will determine the file size and thus influence the final size of the course. Quality issues are also related to media file format.
For example decisions about image depth, sound quality and video format need to be taken relatively early in the production process. The Horizon material requires highest level sound and image files. Great care is taken that information be presented simply and there that are few distractions to learning.

## 12 MATERIAL PRODUCED AS A PROTOTYPE

Larger prototypes are produced at this stage. These are used for evaluation by users experts and for testing. At this stage the material is translated into other European languages and foreign language prototypes are produced. The translation process adds another level of difficulty to the project. Additional problems include the introduction of bugs and errors into already tested parts of the material. It becomes very difficult for the design team to debug an application when in it has been produced in a foreign language version. It is often quicker to send material abroad with a small team to perform testing we have found and indeed this is what happens with Horizon project materials.

## 13 MATERIAL TESTED AGAINST TECHNICAL STANDARDS

This stage is intended to make sure that the system operates efficiently, robustly and performs as expected. This is especially important in the development of the Horizon material. Learners quickly lose interest if the system does not perform well. Staff are quickly discouraged from using systems that let them down and do not perform as expected. This may not always be due to software problems, but in our experience the software is always blamed for poor performance. It is important then that the materials be tested in real situations on equipment that will be used in the final delivery of the application.

## 14 MATERIAL EVALUATED BY USER ACCORDING TO SPECIFIC USABILITY REQUIREMENTS

The material is subjected to a testing and evaluation procedure. Standard methods include user questionnaire, data logging, interviewing, recorded interview, video methods and subsequent verbal protocol analysis. The choice of evaluation method is especially important with Horizon students who sometimes find it useful to work in groups. The process of the evaluation of Horizon materials is described in detail. (Barker T 1997)

## 15 FINAL VERSIONS OF THE MATERIALS PRODUCED

This will involve the creation of a staff / user manual and a robust and simple installation procedure that will also include installation of the final versions of student tracking and recording systems. Issues and problems of final distribution are solved, for example CD ROMs created or network installation undertaken.

Material is then used by staff and students with ongoing evaluation. It is important to make sure as much as possible that evaluations are performed with the student and the final objectives in mind. Too often the media is evaluated and not the learning taking place. The final stage of the project involves feedback and de-briefing with formal written reports.

## 16 DISCUSSION

Any process that is developed to manage multimedia projects for use in FE will need to justify itself in terms of cost and benefit. Excessively complex control methods may be expensive to implement, or be unworkable for small development teams and thus defeat the object of employing them. The management process developed by us is fairly simple and was designed to facilitate the production of material in a reasonable time at reasonable cost. The multimedia design process itself is complex and involves teams of management, lecturing, specialist and technical staff from the earliest stages in the initiation of the project to final user evaluation of material produced. The development process is resource intensive and requires significant management in order that projects be delivered to time and specified standards. Additional constraints with the Horizon work include the need to consider the user as an individual with a unique set of requirements. The coarseness of many of the evaluation methods available to us for such users is noticeable.

The next stage of this work is to look at some of the more complex variables within multimedia learning applications for the Horizon project and to examine evaluation and testing methods. The problem of catering for the individual user was encountered in the Horizon project. This problem was seen to relate not just to the production of multimedia learning materials, but also to issues of testing and evaluation. Individually configurable applications are seen as a natural progression, not only in terms of media quality, quantity and presentation, but also in terms of individual learning style, the use of language and presentation style. The differentiation of the material in this way makes it essential that evaluation be individualised in a similar way.

## 17 REFERENCES


Allessi S M and Trollip S R, (1991), Computer Based Instruction, Prentice Hall.

Arnold S, Barr N, Donelly P J, Duffy C, Gray P, Morton D, Neil D M, and Slater N, (1995), Constructing and Implementing Multimedia Teaching Packages, Edited by P J Donelly, A report by the University of Glasgow's institutional project in the Teaching and Learning Technology Programme.

Barker T, Jones S, Britton C and Messer D J, (1997), The development of tasked based differentiated learning materials for students with learning difficulties and / or disabilities. Proceedings of CAL-97 conference, University of Exeter, March 1997

Barker T, Jones S, Britton C and Messer D J, (1997), Evaluation of Horizon Multimedia Learning Materials for students with learning difficulties and disabilities. Presented at AJTC-97, University of Wolverhampton, September 14-17.

Britton C, Jones S, Myers S M and Sharif M (1996), A Survey of Current Practices in the Development of Multimedia Systems, Technical Report No. 258, Faculty of Information Sciences, University of Hertfordshire.

Dix A, Findlay J and Beadle R, (1994), Usability Paradigms and Principles, Human Computer Interaction, Prentice Hall.

Henderson R, Podd J, Smith M and Valara-Alvarez, H (1995), An examination of four user-based software evaluation methods., Interacting with Computers, 7(4) 412-432.

Howles L, and Pentergill (1993) Designing Instructional Multimedia Presentations: A Seven Step Process, Tech Horizons in Education j., Vol. 20, No. 11

Laws J V and Barber P J 1989, Video Analysis in Cognitive Ergonomics: a methodological perspective. Ergonomics 32(11), 1303-1318.

McAteer E and Shaw R, (1995) The Design of Multimedia Learning Programs. Establishing Multimedia Authoring Skills in Higher Education. EMASHE Group publication, University of Glasgow.

Reeves T C, 1991, Ten commandments for the evaluation of interactive multimedia in higher education, Journal of Computing in Higher Education. 2(2). 84-113.

# Investigation into the effect of Language on Performance in a Multimedia Food Studies Application.

**Keywords:** Multimedia, Pedagogy, Language skills, Multi-modal interface design

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## Abstract:

An investigation into how performance in a multimedia learning application was related to the level of language support available is reported. Teachers from a College of Further Education, National Vocation Qualification (NVQ) level 2 catering students and Higher National Diploma (HND) catering management students took part. After a language and subject pre-test, participants were randomly assigned to presentations of a multimedia catering course having either full, or no additional language support available. Immediately after completion, a post-test and two weeks later a re-test were taken.

No significant difference between staff or HND users with different levels of language support was found. Significant differences were found for the NVQ users with different language support. The results of this study are discussed in relation to language skills and the potential for the individual configuration of multimedia.

## 1.0 Introduction

Blank and Solomon [5] identified deficiencies in language skills in children and suggested that language deficiencies in children related to the lack of a system of symbolic thinking. It is likely that such serious deficiencies in language skills identified early in life would be carried on throughout the education process into adult life, and have a negative influence at each stage of development. Deficiencies in language skills might therefore lead to a poor educational experience and poor achievement in general.

This is especially true for students entering further education for several reasons. There is evidence that many learners have severe linguistic deficiencies when they enter college [2]. In many cases their first language is different from the language in which their selected course is delivered. Specialised vocabulary used in some courses may be a problem for many learners with technical and foreign terms and non-standard usage of words being common. There may also be problems of linguistic style, for example, the use of passive rather than active sentences and the use of past tense in technical writing.

It is sometimes assumed that using multimedia in learning with its use of image, video and animation, will compensate for deficiencies in learners' language skills. Petre [10], however, challenges this view and stresses the importance of text and spoken language in multimedia presentations. This leads to a high requirement for reading and listening skills in the learner. The multi-modal nature of the user interface places additional emphasis on the use of language in multimedia delivered learning. Complex written and spoken instructions are often involved in multimedia learning applications. McAteer and Shaw [7] recommend that authors pay particular attention to the use of language in multimedia applications and provide support when communication is in the form of written text in the application. Barron and Atkins [3] have found that listening skills are also important in multimedia learning applications. Poor use of language in the computer interface may also lead to usability problems in applications. Molich and Nielsen [9] stress the need for clear simple language in the design of computer interfaces.

The objective of the project reported here was to investigate the effect of language on performance in a multimedia learning application. The study was based on food studies courses taking place in a college of Further Education. Catering courses had been identified by language experts in the college as posing special language problems. There were many technical and foreign terms in regular usage and there was a high scientific component in some areas of food studies, for example, food hygiene and nutrition.

A network-delivered computer application was developed to deliver a course based on the food commodities. Teachers from a College of Further Education, National Vocation Qualification (NVQ) level 2 catering students and Higher National Diploma (HND) catering management students followed a multimedia delivered learning application that provided different levels of language support. The aim of the investigation was to relate performance on pre-tests, post tests and re-tests to the levels of language support provided by the application.

## 2.0 Development of the software.

Three pieces of software were developed for this investigation.

1. A computer based tool to facilitate the creation of language differentiated materials (Language level tool).
2. A language testing tool to assess students' language skills
3. A catering commodities multimedia application able to provide differential language support for learners

## 2.1 Language level tool

A computer program was developed to determine the language levels of texts and narratives used in the course. This application was designed to measure the Adult Literacy and Basic Skills Unit (ALBSU) SMOG levels [11]. SMOG levels are used as a standard within many Further Education (FE) colleges to classify learners' reading, writing and listening skills. The SMOG level is calculated from the length of sentences and the number of syllables in words used in a text.
The language level tool was used to analyse sections of text and narrative used in the courses and to calculate the SMOG level of the language used. In this way it was possible to prepare text and narrative at a range of levels.

## 2.2 Language testing tool

The language test was based on a simple listening and gapping test as described by Vaughn [11]. The application tested simple listening and reading skills in the catering subject area.

The test developed followed closely existing language assessment and screening tests used routinely in the college based on the ALBSU SMOG test [11].

## 2.3 Multimedia application

The application was developed by a team of language, subject and computer specialists, using iterative prototyping and user centred methods. A description of the multimedia development process employed in the creation of the materials is given by Barker and colleagues [1].

The programme covered aspects of catering practical and theoretical work, including food science, food composition, food hygiene, storage, handling, nutrition, cookery and other related areas. The domain was selected to be relevant to as wide a range of students as possible. Catering specialists created a full specification for the application, which included text and narrative. After measuring the SMOG level of the language used, in the initial text and narrative, the application was differentiated to provide extra language support in the following ways.

1 Alternative words were provided. Instead of a long difficult word, shorter, simpler words were used.

2 Sentences were made shorter. Long sentences were cut up and presented as several smaller ones.

The effect was to create two versions of the text and narrative for the application, a high level version at ALBSU SMOG level 18 and a lower level version at level 14. These were used to create a prototype of the application differentiated at two language levels. Two pathways were provided through the prototype, a high level language route, set at SMOG level 18 and a lower level language route, set at SMOG level 14. The subject content covered in each pathway was identical.

In addition to reducing the SMOG level, additional language support was provided for the lower level pathway in the prototype by the following measures:

3 Sentences were made active rather than passive in the presentation with additional language support.

4 Additional hyper-linked glossaries and explanations were given where the language might be difficult, for example words like vitamin and protein were explained more in the extra support presentation

5 Additional images and videos were available in the extra supported presentation.

Only redundant information was provided by these additional measures to ensure information provided in both paths was identical.

The prototype was designed so that presentation could be varied within the

application according to the values of variables held in individual configuration files for each user.

- Language level = 0 – High level presentation, (SMOG level 18) with no extra language support
- Language level = 1 – Low level presentation, (SMOG level 14) with extra language support provided

Sound presentation was configurable within the application in a range of ways to allow flexible use. For this investigation, sound was set on, repeatable and interruptible.

## 3.0 Method

Three groups of participants were involved in this experiment. Two groups of students, one following a Higher National Diploma (HND) and the other following a National Vocational Qualification (NVQ) level 2 in catering. A third group of non-catering lecturing staff also took part.

HND and NVQ students, despite their academic separation, follow a similar core course in food commodities as part of their normal curriculum. Differences in their academic levels however meant that these groups had different language support requirements.
The staff group had no vocational or subject experience of catering, yet would be expected to possess good language skills.

Table 1 below shows characteristics of the participants involved in the trial. The language score for each group is also shown in the table.

.Table 1

Language scores and groups of participants in the study

| Group | N | Mean age | Age Range | Mean % Language test score |
|---|---|---|---|---|
| NVQ | 32 | 17.9 | 16-23 | 60 |
| HND | 32 | 19.3 | 17-35 | 81 |
| Staff | 20 | 29.3 | 23-47 | 93 |

Each group was divided randomly into two equal parts. This enabled participants in each group to be assigned to either of the presentation regimes as follows:

Presentation a) without additional language support (none)

Presentation b) with additional language support (full)

Details of sub groupings and the language support presentations given are displayed in the table below.

Table 2

Additional language support, age and language test scores

| Sub Group | Additional Language Support | N | Mean age | Age Range | Mean Language test score |
|---|---|---|---|---|---|
| NVQ a | None | 16 | 18.3 | 16-23 | 62% |
| NVQ b | Full | 16 | 17.4 | 16-22 | 57% |
| HND a | None | 16 | 19.0 | 17-25 | 81% |
| HND b | Full | 16 | 19.5 | 17-22 | 80% |
| Staff a | None | 10 | 29.2 | 23-47 | 94% |
| Staff b | Full | 10 | 29.8 | 23-45 | 92% |

An analysis of variance was performed on the language test scores for all groups. There were significant differences ($p<0.01$) between the NVQ (a and b) groups and all other groups. There was no significant difference between the NVQ a and NVQ b group ($p>0.05$).

## 4.0 Implementation

Participants were given a brief introductory talk prior to first use of the system. Immediately after induction, participants were administered the multimedia language test, followed immediately by the multimedia pre-test of 30 multiple choice questions.

Participants followed the course over a period of one week in open access computer areas. Students were supervised at all times by tutors who could provide additional help related to using the application rather than subject information.

Once the course had been completed, a multimedia post-test and user-evaluation was taken by all participants.

The user evaluation tool consisted of a set of 30 questions delivered on the computer in multimedia format. It measured how interesting the course material was, any areas of difficulty within the course and users' computer experience and familiarity with the use of multimedia hardware.

Two weeks later a supervised re-test was taken in multimedia format, delivered on a computer. The pre-test, post-test and re-test were in the same format and covered the same subject areas. Questions for these were selected randomly from a bank. A subject expert who assessed the tests during the software development process rated them to be of equal difficulty.

All results were saved securely and anonymously on a computer network. An extensive data log file was created for each subject throughout the course. This held information about navigation and time spent in each section of the course.

In summary, the implementation had the following stages:

- Initial language assessment test presentation
- Initial subject pre-test presentation,
- User configuration file created
- Course followed with prescribed language support
- Post-test presentation
- Evaluation of the application by users
- Re-test presentation two weeks after finishing the course.
- Data collected and analysed

## 5.0 Results

In this section, results obtained in the investigation and their statistical analysis is presented. Table 3 below presents the pre-test, post-test and re-test scores for groups following the commodities multimedia course. Results of the user evaluation questionnaire are also presented.

Table 3
Mean Pre-test, post-test and re-test and user evaluation scores for participants following the catering commodities multimedia course.

| Group<br>Possible<br>Score | N | Pre Test<br>(30) | Post Test<br>(30) | Re Test<br>(30) | Evaluation.<br>(5) |
|---|---|---|---|---|---|
| NVQ a | 16 | 11.13 | 14.44 | 12.5 | 3.25 |
| NVQ b | 16 | 12.13 | 18.56 | 14.38 | 3.68 |
| HND a | 16 | 15.81 | 21.44 | 18.25 | 3.32 |
| HND b | 16 | 16.06 | 19.94 | 17.69 | 3.10 |
| Staff a | 10 | 14.50 | 20.3 | 17.1 | 3.20 |
| Staff b | 10 | 16.60 | 22.6 | 18.5 | 3.10 |

The greatest difference in the means seen in table 3 was between the NVQ a and NVQ b groups post test. The NVQ group with additional language support performed on average better than the NVQ group without the benefit of additional support.

## 5.1 Tests of assumptions

The statistical methods used in the data analysis assume that the observed covariance matrices of the dependent variables are equal across groups.

Box's Test of Equality of Covariance Matrices was employed to test the null hypothesis that they were equal.

The observed value of $p > 0.05$ (0.85) compels us to accept the null hypothesis.

Mauchly's test was employed to test the sphericity of the data within groups which is also assumed within the methods used. The observed value of $p > 0.05$ (0.98) compels us to accept the null hypothesis and assume sphericity of data.

## 5.2 Analysis of Variance (ANOVA)

The means of the TRIALS variable (pre-test score, re-test score and post-test score) were subjected to an repeated measures ANOVA to test for the significance of any differences between them. Table 4 below shows the results of this analysis.

Table 4

Tests of Within Subject Effects

Results of repeated measures ANOVA performed on data from table 4.3

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| TRIALS | 1087.727 | 2 | 543.864 | 74.74 | 0.000 |
| TRIALS x GROUP | 10.452 | 4 | 2.613 | 0.359 | 0.837 |
| TRIALS x LANGUAGE LEVEL | 32.177 | 2 | 16.088 | 2.211 | 0.113 |
| TRIALS x GROUP x LANGUAGE LEVEL | 14.818 | 4 | 3.704 | 0.729 | 0.729 |
| Error (TRIALS) | 1135.175 | 156 | | | |

Table 4 shows a significant difference between the means of the TRIALS variable ($p<0.001$). There were significant differences between the mean scores obtained in pre-test, post-test and re-test. Between subject effects were also investigated and results of this analysis are presented in table 5 below.

Table 5

Tests of Between Subject Effects

Results of repeated measures ANOVA performed on data from table 5.5

| Source | Type III Sum of Squares | df | Mean square | F | Sig. |
|---|---|---|---|---|---|
| Intercept | 67519.376 | 1 | 67519.3 | 3010.4 | 0.000 |
| GROUP | 1135.176 | 2 | 567.588 | 25.306 | 0.000 |
| LANGUAGE LEVEL | 158.167 | 1 | 158.167 | 7.052 | 0.010 |
| GROUP x LANGUAGE LEVEL | 38.347 | 2 | 19.173 | 0.855 | 0.429 |
| Error | 1749.438 | 78 | 22.429 | | |

Table 5 shows significant between subject effects for the GROUP and LANGUAGE LEVEL variables.

## 6.0 Discussion

The results are taken to indicate that there were significant differences between the performance of individual groups on pre-test, re-test and post-tests under conditions of different language support. Differences in pre-test scores between the NVQ and HND / staff groups ($p<0.05$) were likely to be due to different abilities, experience and prior knowledge between the groups. In fact HND and staff groups performed better on average in all tests than NVQ groups. This was significant ($p<0.05$) in all cases except for the staff a group in the pre-test. Staff groups performed no differently from HND groups on average in all tests under both language conditions.

A significant difference was found in the re-test results between NVQ groups under the two conditions ($p<0.05$). The NVQ group receiving additional support and lower level language presentation performed significantly better on the re-test than the NVQ group at the higher language level with no support. The provision of additional language support therefore, was most effective for NVQ learners who scored lowest of all groups on the language test. Differences in post-test scores between the two NVQ groups therefore, were ascribable to the additional language support provided within the application.

There are implications of these results for the configuration of multimedia learning materials. When learners have high level language skills, the provision of additional language support is not likely to be effective in improving performance on a multimedia course. When learners have language deficiencies, then it is of benefit to learners to provide additional support and to present language at the appropriate level. Somewhat paradoxically it was not possible to detect differences between HND and staff groups with and without additional language support, even though additional content in the form of images and video were provided with the additional language support. This may have been due to ceiling effects on performance.

All participants undertook an evaluation of the package in the form of a multimedia presented questionnaire. Table 4 shows that groups with the supported presentation on average scored the package higher than those with the unsupported presentation. This difference was greatest between the NVQ groups, those with additional support scoring it higher than those without the benefit of this. This difference however was not significant ($p>0.05$). Although there was also no significant difference between the evaluation scores ($p>0.05$), HND and staff groups with additional language support evaluated the application lower than those without additional support. The slightly lower evaluation scores for the higher level groups following the lower level language pathway providing additional support suggests that this may cause some level of de-motivation of learners with good language skills, though there was no statistical support for this idea.

Failure to find significant differences in the perceived quality of the application in three diverse groups of learners suggests that the provision of differential language support in an application is an important way to tailor it to a specific group of users. In this way learners with poor language skills are likely to benefit from the additional language help available and perform better. Learners with good language skills, who were shown not to benefit from additional language support, may prefer a language presentation at their ability level.

The use of sound has been shown to add to a learning presentation, not only in terms of content and information presentation effects, but it may add audio cues and interest to the application as with music and sound effects, McAteer and Shaw [7]. The use of sound has been suggested to offer benefits when language skills are poor. Barton and Dwyer [4] report that subjects with high verbal skills do

not benefit from the addition of audio information in learning applications. They do suggest however, that subjects with lower verbal skills might benefit from textual / audio redundancy in learning. Kenworth [6] supports this view, suggesting that poor readers benefit from hearing text presented.

Meskill [8], suggests that the control of the rate of language presentation in multimedia applications allows the retention of language chunks in short term memory. This could in itself be important in improvement in performance in learning when listening skills are limiting. Meskill emphasized the potential of multimedia in language learning and sees listening as a skill integral to overall communicative competence.
Co-ordinated visual, aural and textual information employed in multimedia can provide clues to the meaning of the written and aural text according to Meskill. The results of the investigation reported here indicate that the presentation of information at the appropriate language level assists in this process.

The investigation showed that performance in a multimedia learning application is improved for learners when it is presented at the most appropriate language level. It is also suggested that failure to do this will result in less than optimum performance, either by de-motivating learners with good language skills or by setting the language level too high to be understood. The individual configuration of multimedia presentations is an important area for future research.

## 7.0 References


1. Barker, T., Jones, S., Britton, C. and Messer, D., J. (1997) Creating Multimedia Learning Applications in a Further Education Environment, Technical Report No. 271, University of Hertfordshire, Division of Computer Science, January 1997

2. Barnsley, M. (1996) Language screening test results, Language Centre, Internal report., Waltham Forest College, London, E17 4JB

3. Barron, A. and Atkins, D. (1994) Audio instruction in multimedia education: Is textual redundancy important?, Journal of Educational Multimedia and Hypermedia, 3, 295-306.

4. Barton, E., A. and Dwyer, F., M. (1987) The effect of audio redundancy on the students' ability to profit from printed-verbal visualized instruction, International Journal of Instructional Media, 14, 93-98.

5. Blank and Solomon, (1969) How shall the disadvantaged be taught? Language in Education, Open University Press.

6. Kenworth, N., W. (1993) When Johnny Can't Read: Multimedia Design Strategies to Accommodate Poor Readers, Journal of Instructional Delivery Systems, Winter 1993, 27-30

7. McAteer, E. and Shaw, R. (1995) The Design of Multimedia Learning Programs. Establishing Multimedia Authoring Skills in Higher Education. EMASHE Group publication, University of Glasgow.

8. Meskill, C. (1996) Listening skills development through multimedia, Journal of Educational Multimedia and Hypermedia, Vol 5, No. 2, 179-201

9. Molich, R. and Nielsen, J. (1990) Improving a human-computer dialogue. Communications of the ACM, 33(3), 338-348.

10. Petre, M. (1995) Why looking isn't always seeing. Readership skills and graphical programming. Communications of the ACM 38 (6) 33-44

11. Vaughn, J. (1995) Assessing Reading: Using cloze procedure to assess reading skills, Adult Literacy & Basic Skills Unit, London.