INFORMATION TECHNOLOGY IN
TERTIARY LEVEL
NUTRITION EDUCATION

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ABSTRACT

The paper reviews methods for enhancing learning at tertiary level by using information technology, including published examples relevant to nutrition education of adults in other contexts. Teaching may include animations that enhance understanding and personal response systems that provide immediate feedback about student comprehension. Tutorials, practical classes and self-study materials can incorporate a wide range of computer programs. These have been used for many years to permit students to analyse their own diets, which is known to provide useful feedback to enable changes to be made. Students learn from exercises in which they have to improve diets and they can become more familiar with food composition using computer-generated bar charts in a quiz format. Programs can integrate energy expenditure with different levels of activity to energy intake with different diets. Students may learn how vitamins are involved in metabolism by exploring pathways using an interactive program. Student research projects can be enhanced by using a program that helps them write a protocol and the output of statistical programs can be interpreted by a program that reads the screen and explains what it means. Computers can be used as vehicles for simulations of practical situations such as client interviews and they can provide discussion forums for students on placement. Whilst revising before assessments, students may benefit from a variety of testing programs; for example crossword puzzles test their knowledge in an enjoyable way and construction of sentences using words from a list tests their understanding of concepts.

INTRODUCTION

Nutrition is taught at different levels to a wide range of students at tertiary level. In the UK alone, the University and College Admissions’ Service listed approximately 300 awards in nutrition, a substantial increase in provision since the previous review in 1991 that reported only 19 awards in nutrition (Nutrition Society, 2005). Many modular programmes often
combined nutrition with a diverse range of science and other subjects. In 2000, there were 2,065 nutrition graduates of all kinds. Over a 15-year period, there was a 2.7 fold increase in the number of universities in the UK that offered taught postgraduate courses leading to the award of an MSc in nutrition: 19 in 2005, compared with 7 in 1989. There is thus evidence of an extraordinary increase in graduate provision of nutrition training. Nutrition is also required for a wide range of other health-related and food-related disciplines such as medicine, dentistry, pharmacy, nursing and catering. Since children need to be taught some nutrition, it is needed to some degree in training teachers.

Many lecturing staff in tertiary level education find that much of their time is taken up with research and hence development of teaching methods may not get the attention it deserves (Higher Education Academy, 2009). Whilst nutritionists were early adopters of computers to speed up calculation of dietary analyses, they have not generally taken such a great interest in how information technology can be used to enhance their teaching. There are not a great number of publications in this area, but this paper attempts to review some developments and use my experience in an attempt to stimulate nutrition lecturers to evaluate them more fully in future.

ENHANCING LECTURES

Perhaps the most obvious place for Information Technology in the classroom is presentation software such as PowerPoint. In the past, lecturers used the blackboard, then developed the use of overhead projection of acetates or slides, but now PowerPoint has become routine for many. Frey & Birnbaum (2002) reviewed the literature and found one study that showed students could achieve better grades when PowerPoint was used in lectures, and then further investigated students’ ideas of this technology. The majority of students had positive perceptions: 69% agreed that PowerPoint presentations held their attention and 79% perceived their lecturers who used PowerPoint were more organised during lectures. Students particularly valued printing PowerPoint slides as handouts and 91% thought they helped them to study, in particular with reference to emphasis on key points.

The use of PowerPoint to emphasise the key points during a lecture may seem so mainstream now that it hardly deserves this attention, but there are many issues in nutrition that are complex and can benefit from the use of animations that are easy to achieve in PowerPoint and similar software. Figure 1 illustrates a slide the author uses to explain how blocking can be used to design a study comparing additional Zn to a control diet by choosing subjects that match in starting weight. During the lecture, the figures with similar weights move on a mouse click to their positions in each block using a custom path.

Flash videos are even more useful when trying to explain complex material, especially metabolic pathways or control of metabolism. For example, a Flash video was used successfully to illustrate part of a figure explaining how transcription factors are involved in the control of macronutrient metabolism (Wise, 2008a). In this case, glucagon is shown interacting with its receptor, causing production of cyclic AMP and the phosphorylated transcription factor CREBP is shown promoting production of PGC-1, which will later move to a second DNA sequence in the video to enhance the promoting effects of HNF-4 in the transcription of genes for enzymes involved in gluconeogenesis. Since this is such a complex
series of events, it is very difficult to explain without graphical support. During the lecture, the video is played in steps and the previous steps can be repeated on request until the students feel that they have understood the mechanism. The video can be made available for students to study later when they wish.

Another technology that has been developing considerably lately is known by several different names, for example the personal response system (eInstruction, 2009). Using radio receivers and transmitters in clickers, students can interact with the lecturer in large numbers during a lecture and provide instant feedback to questions, which can be linked to a PowerPoint presentation. The manufacturer claims that this method allows you to immediately chart student responses, increase class participation, identify areas where students need more help and encourage group and peer learning.

Gachago (2008) has undertaken detailed research into the use of this system by 31 science lecturers at the University of Edinburgh. Several lecturers used clickers in innovative ways, such as encouraging students to discuss with their peers before voting (n=10). Some lecturers also ask students to re-vote on questions (n=13), after having explained a question in more detail or allowing students to discuss with their peers. Three lecturers used confidence levels, which show how confident students are when selecting a voting option. Confidence levels in conjunction with re-voting is said to give some interesting insights into students’ increasing level of confidence in their own knowledge and understanding of a concept. The lecturers were asked to rank by importance several reasons for using clickers and with a maximum possible score of 500 they considered that the system: increases interaction between lecturers and students (score=456); provides feedback on students’ understanding of
content (score=437); reveals common misconceptions amongst students (score=415) and helps students understand difficult concepts better (score=406).

**SELF-STUDY PROGRAMS**

**Underpinning Subjects**

Tutorials, practical classes and self-study materials can incorporate a wide range of computer programs. One of the underpinning elements to a nutrition course is biochemistry and in particular they need to understand metabolic pathways involved in processing and use of nutrients. Nicholson (2008) has produced a series of Flash videos that show how the molecules glide in and out of enzymes and the reactions are well explained step by step at http://www.iubmb-nicholson.org/animaps.html. The well-known wall chart produced by Roche Applied Science (2009) can be accessed online and users can search for a key word or click on the map itself to see part of it. GenomeNet (2002) provides overview diagrams illustrating sections of metabolism with hotspots that can be clicked to provide detailed information on the enzymes including amino acid and base sequences. These resources are extremely valuable for students who are studying biochemistry in depth, but they are arguably too complex and information intensive for many nutrition students. The metabolic pathways program was designed to help nutrition students learn about the main metabolic pathways, and in particular the ways in which vitamins are used in metabolism (Wise, 2002a). The approach to program design was to make it as interactive as possible to enhance exploration and understanding of interrelationships between substances via the inclusion of many hotspots on the screen for navigation and provision of relevant information.

The top frame contains a menu, which includes links to a ‘contents’ page or a popup map showing the outline of basic metabolic pathways (see Figure 2). There is a menu item that provides a list of vitamins that are required as coenzymes, for example choosing folate leads to a list of reactions requiring it, each of which can be clicked to show the pathway on the left of the screen. Clicking on the arrow between the two substrates generally shows the structures of the metabolites along with the name of the enzyme, and clicking on the coenzyme gives its structure and list of reactions requiring it. Since some metabolites also act as allosteric modifiers elsewhere in metabolism, this is indicated when appropriate so that the student is taken to the reaction to see what effect it has.

Research is an important aspect of nutrition so that students need to learn research design and statistical analysis. This is a notoriously difficult area to teach and for students to comprehend fully so if they can study using information technology and gain some insights doing so this is a very useful application for their learning. Although statistical programs are very powerful tools for statisticians, unfortunately they tend not to be very simple and the output may be difficult to interpret. Therefore, if students undertake a practical class in statistics applied to nutritional problems, they are continually asking what the information means, or they just look at it cursorily and do not understand but are too embarrassed to say so. In order to try to improve on this situation, a program was written by Wise (2003) that reads the screen of the statistical program Minitab and interprets the figures on it for the student (see Figure 3). This was not as highly rated as some of the other support material for
this subject, but it has been improved since then and seems to be helpful to students since they are observed to use it frequently and they ask fewer simple questions during practical classes.

![Metabolic pathways program](image)

Research methods do not only contain statistical tests, but include a wide range of material to enable them to comprehend the scientific literature and undertake research: sampling, type I and type II errors, validity, confounding, definition of units, levels and factors, and a host of different types of bias and ways to attempt to avoid them (Heath, 1995; Huck & Cormier, 1996). It is particularly important that students should understand these concepts and apply them in their reading of the literature, so the examination includes simulated sentences from research papers with blank spaces to complete. A program was written that appears in a web page and 20 sentences are chosen at random from those that are similar to the ones in the examination. Each sentence has two spaces to be filled and the 40 missing words are arranged in alphabetical order on the left of the screen. When students think they have identified a missing word, they indicate it and the place in the sentence where they think it belongs. If they have correctly identified the missing word, the sentence is rewritten to include the word. It was generally agreed that the sentences could not easily be guessed by using grammatical rules and that the puzzle program had helped them to understand the material and prepare for the examination. Most (78%) students copied many of the sentences in the puzzle program onto paper for use in the open book examination and 69% agreed that the program was clearly laid out and easy to operate. When comparing this program with eight other types of support materials provided in the module, average scores
(out of 10) were in decreasing order 8.28 for the mock examination, 8.09 for the handout and then 7.53 for the web-based puzzle program. It is interesting to note that students differed considerably in their opinion of the different support materials. For each of them, there was at least one student who rated it 0-2 and another who rated it 9-10. Thus it is important to provide a wide range of types of support material to cater for the individual learning styles of each student and it can not be expected that all will engage with methods involving information technology. This type of program in which students build sentences can also be used in a wide range of nutritional subjects where understanding of concepts needs to be built.

![Minitab Interpret](image)

**Figure 3. Interpret Minitab program**

**Applied Nutritional Subjects**

Programs have been used for many years to permit students to analyse their own diets, which is known to provide useful feedback to enable changes to be made (Kroeze et al. 2006). Although it may be argued that students only need to learn information to pass assessments, if they are to help others to change their diets it may be a good idea to be able to do this themselves first. Students also learn from exercises in which they have to improve diets because they have to search for foods that would be nutritionally more appropriate than those
in the diet provided. An example of this concept is shown in Figure 4. Students were provided with a diet designed to be able to be considerably improved if they could find and apply 8 different nutritional messages to the client, for example to change from white to wholemeal bread. They can be assessed by what proportion of these messages they employ and the report they write about the changes they suggest. The main requirement to facilitate this type of educational experience is to provide students with a nutritional analysis program designed for education such as WinDiets (www.windiets.com; Wise, 2006; Wise, 2008b).

![Figure 4. Exercise for students to improve a diet](image)

The innovation in WinDiets that is particularly designed to help students choose appropriate foods is that the program is designed around a web-based window in which pictures and colours are used to provide information along with the expected dietary analyses in tables and graphs. It is important that students get an understanding of portion sizes of food so they can look at photographs of different weighed portions of a variety of foods in the program. This is facilitated by providing a list of foods that match search criteria, each with a background colour, the intensity of which relates to the amount of a chosen nutrient in the food. Students can preview the main nutrient content and information about portion weights of the foods on the screen by clicking those that appear in the list. A particularly novel feature of using colour intensity is a screen that permits students to compare two foods directly for energy content. Colour intensity is also employed to show visually what foods contribute most to the main nutrients in a meal (see Figure 5).
Figure 5. Composition of a meal illustrated using the intensity of colour

Another method that can be used to help students learn the main nutritional components in foods is a screen that presents a quiz of the composition of foods in which nutritional analyses are shown in bar charts compared to dietary reference values (Wise, 2002b). The quiz screen has been developed so that it contains a program that randomly presents a bar chart of an individual food and provides a list of 10 foods to choose from, including the one in the bar chart. After choosing a food from the list, students are shown the correct answer if they made a mistake and they are provided with a score that they can try to improve by choosing a higher proportion of correct foods. Students are unlikely to be able to buy this program, but many of them have computers at home and use them for study. Therefore, WinDiets permits the building of a quiz by selection of appropriate foods to include and export of the resultant quiz as an independent web page that can be put on the lecturer’s web site for student use at home. Second stage students were shown the program in a tutorial and 16 of the students completed an anonymous questionnaire about their attitudes to the program. Most (n=15) found it user-friendly and agreed that they were more motivated to learn by having the score of their attempts than having no score (n=14). There was little agreement with the proposition that they would prefer to learn about nutritional composition from a book than a computer (n=1) and there was overwhelming disagreement (n=15) with a statement that ‘food composition is such a simple subject that it does not deserve time in an Honours Nutrition course’.

Programs can integrate energy expenditure with different levels of activity to energy intake with different diets. These depend on the basal metabolic rate (BMR), which can be applied during sleep and the extent of physical activity during the day. The UK Government’s publication on reference nutrient intakes suggests a method for calculating individual energy requirements based on BMR and activity (Department of Health, 1991). A simpler Internet version of the program showed how manipulating factors can alter energy balance (Wise & Cowie, 2005). It helped students to test out the effect of varying lifestyles on energy requirements and has been incorporated into WinDiets. The screen has a grid of numbers on the right. Each of these represents what a person is doing for a 5-minute period. There are 12 figures per hour and when a student enters the program, the data are all set at 1 to represent the physical activity ratio (PAR) of sleep. The student selects a time of rising by clicking the relevant part of the grid. The student can select from one of the eight PAR buttons on the left of the screen. This is entered into the grid and the student can continue clicking the buttons on the left of the screen and the data is entered into the grid until it is time to retire to bed again. The program was used in a practical class to introduce the way energy requirements depend
on activity. Students were instructed to enter data typical of a sedentary person, and then discover how requirements alter as people lose or gain weight. They were told to alter the data to include a tennis match or other sports activity. It may be particularly surprising how little this may alter energy expenditure, especially if students are told to calculate what difference a single tennis match would make over a week. Having found the extra energy needed for exercise, students can calculate how much fat could be lost and how long it would take to achieve substantial weight loss assuming the energy value of tissue lost. Assuming 38 kJ/g for fat, the least weight that could be lost would be 26 g/MJ deficit, but since adipose tissue contains more than fat and other tissues are also lost during periods of negative energy balance, a higher value would be appropriate (Garrow, 1978). In the first few days, a high proportion of water is lost but after a few weeks of negative energy balance, losses of about 32 g/MJ could be predicted. Another exercise that was very revealing to students was to provide them with some confectionery that contains a nutritional label and calculate how long they would have to run before they have oxidised this energy-rich snack.

This tutorial has been improved by using screens in WinDiets that permit selection from about 600 different activities and outputs energy balance every hour during the day. Figure 6 illustrates part of the work involved in the tutorial. A subject is simply lying all day but eats three meals and is in energy balance at the end of the day. Then she takes some confectionary as a snack in the morning and is in positive balance over the day. Finally she plays an hour of tennis in the afternoon and is back almost in balance so the student can see that the confectionary requires an hour of tennis to oxidise it.

![Figure 6. Graph of energy balance during the day to illustrate the importance of diet and activity](image)

Students studying nutrition and dietetics may use specially written programs to help prepare them for the clinical environment (Herriot et al. 2004). The program facilitated learning how to take a diet history, to calculate nutrient intake and then use this information, together with an understanding of an individual’s medical and social history, to advise on dietary change. The majority of students believed the program was a good method for preparing them for placement and particularly highly rated it for the dietetic interview, dietitians record card, medical notes and doctor’s referral letters.

Litchfield et al. (2002) also claimed that online education of dietitians improved their performance in certain aspects of their competence. Turner et al. (2000) investigated the use of two different computer programs so that use of a computer was not a confounding factor, but this means that it can not be shown that either was better than another form of education.
They produced a care planning simulation system with 3 patient cases and students accessed patient information and developed a dietetic care plan. This was compared to a program that covered data collection, interpretation and care plan development in a drill and practice format. Performance on placement was then rated by dietitians and it was found that those who learned through the simulation program improved their performance faster than the other students.

Maiburg et al. (2003) designed a simulation of a general practitioner’s consultation consisting of 12 interactive streaming-video patient cases presenting with complaints related to nutrition (i.e. food pyramid, obesity, diabetes mellitus, hypercholesterolemia, hypertension, irritable bowel syndrome, and constipation). After a plenary instruction session by the researcher, the GP trainees went through the program at their own pace during these sessions and this process took an average of 6 hours. The control group took the regular vocational training program but their knowledge did not increase as much as those using the program.

Whatever method students have used to learn, they need to revise before the summative assessment and it has been shown that nutrition students may benefit from the use of crossword puzzles that test their knowledge in an enjoyable way (Wise, 2001). The puzzles appear in a web page and students have to move the mouse over the first letter of a word to reveal the clue, some of which are cryptic and others simpler. They enter each letter by moving the mouse over the blank space on the screen and typing it. Students could not agree whether cryptic clues are enjoyable or whether puzzles are only worthwhile if clues are simple and not cryptic.

The strongest attitude shown by students was their strong agreement that crossword puzzles show them what they need to study more thoroughly. They also agreed that crossword puzzles: help with spelling of technical words, challenge students to answer without looking at their notes, help students to test their knowledge in a different format, give confidence that they have learned more than they realised when they can get the right answers, help them to concentrate on the material, give a sense of satisfaction when completed and help them to learn whilst having fun.

Computers are more often being used for distance learning and to replace lectures with self-study packages. Many different programs have been designed to provide formative feedback during learning. There are many different multiple-choice types of approach available and some of these may also be used for summative assessment at the end of courses. There are arguments against these simple programs though and it has been shown that through the use of feedback during study, students can improve weaknesses in learning and thinking, increase and transfer learning, and value opportunities to revise (Wang, 2007). Thus it is suggested that it is important for teachers to provide learners with opportunities for receiving ‘timely feedback’ and ‘repeating the test’. When students have the opportunity to repeat the test, correct answers should not be given but only reference to where to find the answer. The program described automatically chooses some questions when the student logs in randomly from the database. A given test item will not show up on the following test if a learner correctly answers the test item three times consecutively.

Thus, the number of test items will gradually decrease with each iteration of the test. At some point, all questions will be answered correctly, and the system will tag the successful learner with a ‘pass the test’ mark. By the same token, if learners cannot answer the test item correctly three times consecutively, then the answer count will be reset to zero and begun again. Answering a test item correctly three times consecutively is considered necessary
because the system judges that the learners may answer the question correctly simply by guessing. The purpose of this design is for learners to actively take on the challenge of learning, not passively guess their way through.

**RESEARCH AND PLACEMENT**

When students have undertaken sufficient education in nutrition, they may include in their course some experience of undertaking research and working in a placement. Student research projects can be enhanced by using a program that helps them write a protocol (Wise, 2002c). Important aspects of a research protocol include a definition of the research problem, sufficient detail about the plan of work, reasons for selecting the specified approach, and information related to how research funds will be allocated. The scientific method implies a logical derivation of conclusions by means of inference correctly drawn from reliable data. The analysis of experimental data is, therefore, a critical stage in every research study and statistical tests are required for most nutritional research and this should form an important part of the overall method described in the research protocol. At honours level, students have to design their own research project and write a simple research protocol to convince the supervisor that the student has sufficient understanding to design a study that is likely to be successful. It is useful practice for the possibility that the student will later be involved in actual research, to make this exercise as realistic as possible. In order to prompt the student to include the most important aspects of a research protocol, especially the statistical ones, a computer program has been developed. The student moves through various steps in which information is provided to remind the student about the relevant material taught earlier in the module on research methods. After filling in information and answering questions, the program writes a draft protocol suggesting a statistical test. The student is then expected to revise statistics sufficiently to be able to justify whether this is an appropriate test. The most positive feature of the program seen by the students was that it had ‘links to useful material on the Internet’. There was also agreement that the program ‘helps to clarify what is needed for my protocol’, ‘provoked me to think of aspects of the project, the importance of which I might have failed to realise early enough’ and ‘provoked me to ask appropriate questions of my supervisor about the project’.

Information technology can provide a learning experience whilst students are away from the university in a work placement. Kolasa et al. (2001) reported how medical students are expected to apply their nutritional knowledge by observing physicians on placement, but that students reported that few of their physician preceptors refer or counsel patients on dietary change. It was therefore decided to set up a discussion forum in which experienced physicians could reply to questions and points made by students whilst on placement. All questions were answered but many students apparently registered and only read the discussions without taking part themselves. Students were asked to evaluate the forum but only 10 of 72 medical students replied, but these were positive about the experience.

Another approach has been tried for our nutrition students in which they were encouraged to use a discussion forum to write about what they were doing on placement in a similar way to the report by McGugan & Peacock (2003). There were 9 nutrition students who undertook simultaneous placements in different work environments. Participation in the forum varied
from only 2 communications from one student to 15 from the most prolific (see Figure 7). The most prolific student made the following comments on return from placement:

![Cumulative graph to show contributions to a placement discussion forum by individual students](image)

‘I thought the discussion forum was a really good thing. It helped us stay in touch with each other over placement and learn about what else a nutritionist could be doing. I also think it helped me make a definite decision about the type of nutritionist career I wanted. The blogs I had written also helped with the placement report. While reading the blogs again, I remembered small bits and pieces that could go into the report.’

**CONCLUSION**

Information technology is useful for helping lecturers organise nutritional knowledge, animate presentations to make it clearer and interact with students. Various types of programs can be used to support self-study, for example of metabolism, research methods, dietary analysis, energy requirements for activity, and aspects of practice. The use of computers to enhance communication between students should also be considered, for example whilst they are on placement.

**REFERENCES**


