COMPARATIVE NUTRITION
FROM PRINCIPLES TO PRACTICAL FEEDING SYSTEMS

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Abstract

A problem-based online interactive teaching tool for nutrition has been developed structured around a General Animal Model. Supported by tutorials, the student applies concepts and mathematical processes for estimating animal nutrient requirements, assessing the nutritional value of food ingredients and formulating rations. Application to nutrition of each animal species is on a comparative basis, showing changes in equations and the underlying reasons.

Keywords

learning tool, nutrition, problem-based, online, mechanistic

Introduction

Based on 38 years experience in teaching nutrition and evaluating graduate proficiency, three key issues in the learning process have been targeted.

(i) Nutrition involves a widening variety of dietary ingredients. They include novel feed materials and materials modified by modern processing methods, affecting efficiency of digestion, absorption and utilization of nutrients in a complex manner affecting the balance of nutrients absorbed. Though students are well able to access descriptive information about the chemical nature of specific nutrients in food and about the metabolic pathways they enter in the animal, they are less well prepared to deal with interactions in quantitative terms or with the way in which the rapid analytical methods used in nutrition laboratories lump together different chemical entities for ease of calculations or for information transfer.

(ii) In going from qualitative description of digestion processes, absorption, metabolic pathways, and partitioning of substrate use between tissues, the mathematical representation of the processes in quantitative terms is often not sufficiently transparent. The equations and ways in which the calculations are made is often perceived to be empirical rather than an approximate mechanistic model representing nutritional processes in an effective and reliable way.

(iii) In quantifying the nutrient requirements of any animal or the ability of a diet to supply those nutrients, there are general conventions that the science has established. The forms of equations and calculations that are widely applied at any time represent only the “current best approach”. Contemporary nutritionists differ to a degree on the form these models take. Thus there are different methods used in different countries and for different animal species. Students need to be prepared for the debate and changes in these constructs as new knowledge, new feed ingredients and new specifications or tolerances for nutritional requirements appear.

A problem-based online interactive learning program with a study guide, guide to tasks and supporting tutorials has been designed and used for teaching 2nd year Bachelor degree students. A key objective is to improve the problem-solving skill of each student, using this to impart a sound understanding of the biological basis of nutritional concepts and help them to adapt their calculations to suit a specific situation. A further objective is to ensure easy addition and modification as new knowledge and challenges arise in the discipline of nutrition

Program Overview

From the designers' point of view, the product 'Comparative Nutrition' is an attempt to address these issues. The unique features are:

- The tool is primarily **problem-based**, with tutorials that can be accessed and drawn on in solving problems set at a range of different levels of complexity. The student is introduced to the program through a 'Study Guide' that details the pathways that can be followed.
- The **Problems** are arranged so that the mathematical constructs that represent basic principles are explained and applied. Each Problem has a 'Guide to Task' that gives clear instructions on the process to be followed or the knowledge required. As a student progresses the 'Guide to Task' for successive problems becomes less specific or definitive of the process required.
- The **Tutorials** are developed in a matrix in which in one series, key **Concept** topics in nutrition are drawn together while in a second series the **Fact** or Content material is provided.
- The **Solutions** to most Problems will require calculations or the application of formulae or equations to values for the variables identified in the problem.
  - All calculations will be conducted in a dedicated spreadsheet.
  - If the equation or form of calculation is embedded in the spreadsheet it will be visible so all calculations are transparent.
  - Where an equation has to be imported it can be found in a Tutorial and a summarizing Table, or the student may be required to derive it from principles laid out in the 'Guide to Task'. The conceptual basis, derivation and explanation of a calculation will be found in the reference Tutorial.
  - The values of variables to which the equations or the steps in calculation are applied will be found as data either presented in the problem, obtained from **table of values** or a result of a measurement made in a practical/laboratory class.
  - The formulae in the first instance will be as general as possible to establish the broad conceptual basis of the form(s) of equation in common use.
- **Progression** in the learning program is established only by successful submission of a solution to each problem in a series.
  - The solution submitted is in some cases numerical and can be assessed automatically, and feedback given. In some cases the feedback will provide a diagnostic process that will aid in repeating the work and submitting a revised solution.
  - In other cases the student will submit a qualitative written answer requiring assessment by a tutor, with feedback.
- The Class tutor will at all times have access to the progress of each individual student, where the completion pattern and the pace of work can allow review of conceptual or mathematical difficulties with the student.
- **Student Evaluation:** Students enrolled in the subject will be set an assessment requirement to submit solutions to problems. They will, each year, be asked to complete a questionnaire constructed to identify strengths and weaknesses of the program. The principle criteria will be clarity in presentation, ease of progress and navigation and the effectiveness of the problems in elucidating the relationships between the qualitative knowledge and quantitative processes in problem solving.

Essential System Components

From the students' point of view, the main components of the system are:
Problems: These involve the calculation of the nutrient requirements of specific animals and the

feeding value of certain foods in combination to create numerical results and/or written recommendations. The process by which students go about solving these problems is shown in Figure 1.

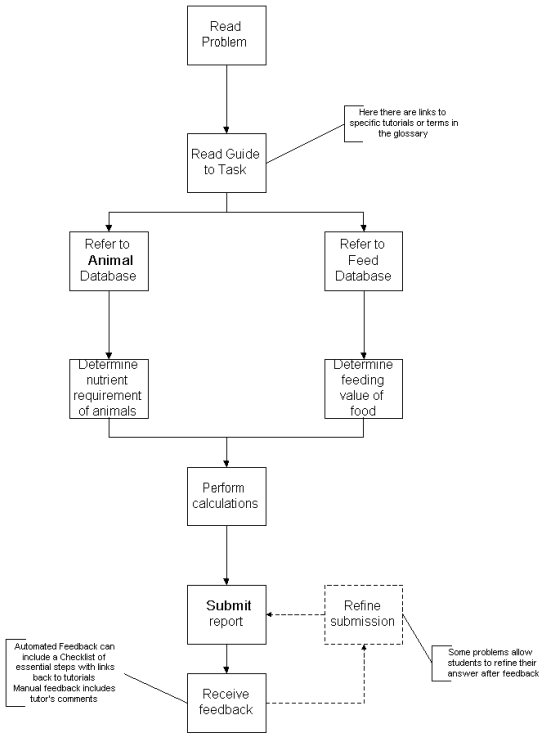

Figure 1: Process flow of student solving a set problem

The problems are divided into 'General Animal Model' and 'Specific Animal Model' problems. The General Animal Model serves to assist students master the fundamentals of animal nutrition by modelling on an animal eating an idealised food source ("cookies"). The style of the problems are either "learning mode", in which the students obtain mainly automated feedback, or "assessed mode", in which the students' work is assessed and feedback is from a tutor via the web.

Tutorials: A series of interactive tutorials has been developed and is based on a set of mini-problems. The tutorial series starts with basic concepts and becomes progressively more complex. Each tutorial session is self-contained with students working through a set of steps involving data input, calculations, and, in later tutorials, exploration and investigation.

Animals: This section includes animal species, class of animal, animal simulators (mathematical models), animal requirements calculator, and animal requirements tables.

Feedstuffs: This section includes feed components, feed analysis, feed chemical composition, nutrient classes, and a feed composition table.

Fact Files: acts as a repository for other resources such as articles, references, links, glossary and study guide.

Problem Design

General Animal Model Problem: The typical structure for a General Animal Model problem page begins with a problem statement. The 'Guide to Task' section sets out a number of steps the student must follow to solve the problem. A link to a pre-defined Excel spreadsheet allows the student to make the necessary calculations in a guided manner. In a final step the students transcribe their answers from the spreadsheet into the text areas provided within a web page form.

After students have submitted their answers, the system provides automated feedback. The students are guided to the next problem, or reminded of the essential points via a checklist, or provided with a tutorial, or put in touch with a tutor depending on their success or otherwise at answering the problem.

Assessed Specific Animal Problem: The typical structure for an assessed problem's web page begins with a problem statement. The 'Guide to Task' section sets out a number of steps the students must follow. The students must solve the problem by creating their own spreadsheet solution. The students then upload their spreadsheet files to the appropriate directory and enter the text of their report in the area provided on the web page. When they click submit, their report is stored under their own username in a database (Fritze, 2000). The tutor then makes annotations on the student's report and enters a mark using a specially designed web page linked to the same database. The student can view the tutor's comments and grade by accessing a feedback page.

Tutor's Pages

The Tutor's Home Page contains some introductory text for the tutor and links to the following pages:

Tutor's Problem Overview Page: This displays information about the problems such as the problem description, problem number, concepts, whether the problem is of type learning or assessed, and whether the feedback given is automated or manual (tutor). An icon displayed under 'Interactions/Feedback: Tutor' links to the feedback page for that particular problem so the tutor can access the students' work and provide each individual with appropriate feedback.

Progress Page: lists the students and the problems. As each student submits a problem, an icon is displayed in the student's row under the corresponding problem's column. This provides the tutor with a visual monitoring of an entire classes' progress. The student's name is linked to that particular student's overview page so that the tutor can view that particular student's work.

Implementation Process

Thirty-eight students enrolled in the subject 212-220 Animal Science 1 (Semester 2, 2001) were provided with access to the product online. During a four-week period they were set an assessment requirement to submit solutions to four General Animal Model problems. They were then asked to complete a questionnaire constructed to identify from the user's point of view the strengths and weaknesses of the program in terms of clarity in presentation, ease of progress and navigation and the effectiveness of the problems in elucidating the relationships between the qualitative knowledge and quantitative processes in problem solving. The results of the survey, yet to be completed, will be presented at the Conference. The further development of the product will be guided by regular evaluative processes.

References

Fritze, P., Welch, S. R. & Ji, G. (2000). Foundations of a component frame work for rich online learning activities. *Proceedings of the Apple University Consortium Conference*. (pp. 7.1-7.11). Wollongong. University of Wollongong.