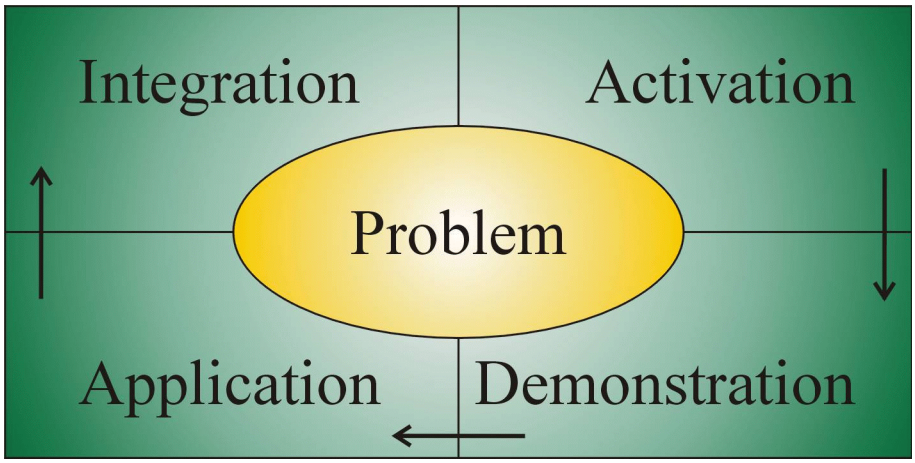
The design and implementation of a computer-based course using Merrill's model of instructional design



by

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Abstract

This dissertation is the developmental research report on the design and development of a multimedia tutorial on Anthropometry for university-level health science students. The practical implication of using Merrill's Model of Instructional Design for developing course work for senior students in the health sciences was investigated.

The multimedia tutorial was designed and developed, and the prototype evaluated by a team consisting of subject and education experts. The prototype was tested by third-year dietetic students who had completed the lecture-based and paper-based course. The students were observed while using the program, then completed a structured questionnaire and finally were given the opportunity to express their views in an informal group discussion.

It was found that if the activation of relevant existing knowledge does not take place, Merrill's Model will be turned inside-out: the student's own problem replaces the instructional problem.

Keywords

- adult learning
- authoring tools and methods
- computer-assisted tutorial
- evaluation of CAI systems
- formative evaluation
- instructional design model
- media in education
- simulations

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List of Acronyms

ADDIE	Analysis, Design, Development, Implementation and Evaluation
CAE	Computer Assisted Education
CAL	Computer Assisted Learning
CAI	Computer Assisted Instruction
CBI	Computer-based Instruction
CIE	Computer Integrated Education
DADI	Definition, Architecture, Design and Implementation
ICT	Information and Communication Technologies
NRF	National Research Foundation
NTA	Nutritional Assessment
NTB	National Training Board
OBE	Outcomes-based Education
PBL	Problem-based Learning
SAQA	South South African Qualifications Authority
SETA	Sector Education and Training Authorities
SME	Subject Matter Expert
TLEI	Telematic Learning and Education Innovation
UP	University of Pretoria
WHO	World Health Organisation

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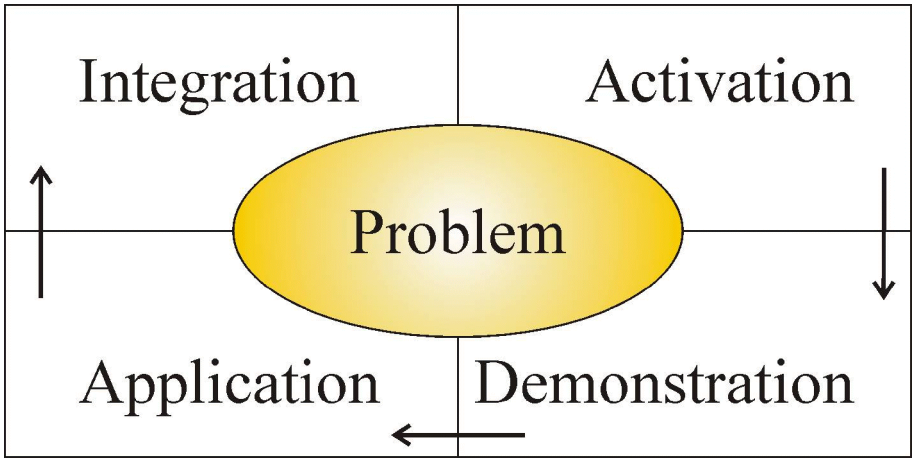
Chapter 1 - Problem



"Learning is facilitated when a learner is engaged in solving a real-world problem."

(Merrill, 1997, p.5)

Chapter 1 - Problem

1.1 Introduction

This essay reports on research conducted to determine the aspects to be considered when using Merrill's Model of Instructional Design. Merrill's Model was used to design and develop course work for senior students in the health sciences. The formative evaluation of the prototype was done by third-year dietetic students who had completed the paper-based course.

This research concluded with the formative evaluation of the prototype.

1.2 Background

1.2.1 Lifelong learning

Worldwide, political, social and economical structures are changing at an ever-increasing rate. These changes place an increasing strain on the educational systems that have to prepare learners for their roles in an ever-changing society. Companies need "employees who can take initiative, think critically, and solve problems" (Reigeluth, 1999, p. 18).

James Burke, a science journalist as quoted by James Gleick (1999. p. 81), comments,

> The rate of change will be so high that for humans to be qualified in a single discipline - defining what they are and what they do throughout their life - will be as outdated as quill and parchment. Knowledge will be changing too fast for that. We will need to re-skill ourselves constantly every decade just to keep a job.

In response to this strain, the focus of education and training is changing from educator-centred or teacher-centred to learner-centred. Learners are expected to pace their own learning and to become lifelong learners. Brophy defines lifelong learning as:

> a deliberate progression throughout the life of an individual, where initial acquisition of knowledge and skills is reviewed and upgraded continuously, to meet the challenges set by an ever-changing society.
>
> (Brophy et al. as quoted in Friedland, 2001, p. 49)

1.2.2 Lifelong learning in South Africa

Education and training in South Africa is also undergoing major changes. In 1981 the National Training Board (NTB) was established as the advisory board to the Minister of Labour to oversee the planned restructuring of education and training in the country. The National Qualification Framework (NQF) was established in 1995 and is currently setting

> a systemic framework for organising the education and training system around the notion of learning outcomes, from the end of compulsory schooling through to postdoctoral research in higher education and training, Additional priorities are systems and processes which support the tenets of democracy and outcomes-based education as an approach to education. (SAQA,. 2001, online)

Not only is the education system changing towards an outcomes-based approach, but from the White Paper on Education and Training (1995, online) it is clear that South Africa is also striving to educate towards lifelong learning. This is set out in the following paragraph,

> Successful modern economies and societies require the elimination of artificial hierarchies, in social organisation, in the organisation and management of work, and in the way in which learning is organised and certified. They require citizens with a strong foundation of general education, the desire and ability to continue to learn, to adapt to and develop new knowledge, skills and technologies, to move flexibly between occupations, to take responsibility for personal performance, to set and achieve high standards, and to work cooperatively. (SAQA, 2001, online)

1.2.3 Lifelong learning and e-learning

Educational institutions have to think of ways and means to accommodate the needs and demands of the lifelong learner. These learners need flexible learning environments and because of this educational institutions are investigating the advantages technology may offer. Friedland however warns of difficulties in the South African context,

> South Africa's e-readiness - the degree to which a country is ready or willing to integrate information and communication technologies (ICT) in its society or economy - is poor in comparison with the rest of the world, but rates high in comparison with other countries in Africa. (Friedland, 2001, p. 99-100)

The University of Pretoria is the largest residential university in South Africa and is committed to providing excellence in education. It is systematically establishing flexible learning environments to address the education needs of students who cannot be on campus. The Department of Telematic Learning and Education Innovation (TLEI) was established in 1997 to assist lecturers with "the innovative integration of contact tuition, paper-based distance education and electronic education" (TLEI. 2002, online). Its services include the instructional design and development for multimedia and web-based learning.

The TLEI supported this research project in a number of ways and is mentioned in the relevant sections of this report.

1.3 The Research Problem

1.3.1 The aim of the research

A multitude of instructional design models are being developed to assist the instructor in his changed role as facilitator, rather than being merely a source of knowledge. This study investigated the practical implications of using one of these models, Merrill's model of instructional design, for developing course work for senior students in the health sciences.

The Anthropometry course for third year dietetics students uses resources that are regularly updated by large pharmaceutical companies and also by institutions like the World Health Organisation (WHO). This made the course particularly suitable for presentation aided by electronic media. Merrill's approach of putting a real-life problem into the centre of the

instructional episode is particularly suited to the problem-based learning approach followed in the Faculty of Health Sciences and it was decided to use his model rather than another one.

1.3.2 The objectives of the research

The specific objectives of this study have been to:

- design and develop a multimedia tutorial for senior students in the health sciences using Merrill's Model of Instructional Design
- formatively evaluate the prototype program
- assess changes to improve the program
- reflect on the relation between Merrill's four phases, **Activation**, **Demonstration**, **Application** and **Integration**.

1.3.3 Scope of the project

The first three steps of the Analysis, Design, Development, Implementation and Evaluation (ADDIE) design process model were used for the project. The project concluded with the formative evaluation, which is part of the Development phase, of the multimedia program.

1.4 The Research Questions

1.4.1 Research questions

Research questions were formulated as follows:

- What is the role of a real-life **Problem** in a digital learning environment?
- What is the importance of **Activation** of relevant experience or existing knowledge?
- How successful can **Demonstration** be in a digital learning environment?
- How significant is the **Application** of the new knowledge under guidance in a digital learning environment?
- Is effective **Integration** of new knowledge possible in a digital environment?

1.4.2 Previous research

To place this essay in the context of other research done in South Africa, a search on related topics was done on the Nexus database, a database of all theses and dissertations, which is maintained by the National Research Foundation (NRF). Related research topics are listed in the table below.

Author	Title	Year	Degree
Dlomo, L.C.	*Simulation - its Reliability as an Evaluation Tool for Clinical Proficiency among the Diploma Student Nurses at Ngwelezane College of Nursing*	unknown	MCur
Dolo, R.J.	*The Implementation of Computer Assisted Learning in the Teaching of Chemical Change*	2000	MSc
Fresen, J.W.	*Random Variables: a CAI Tutorial in Statistics for Distance Education*	1997	MA
Jacob, S.	*The Use of Interactive Computer Simulations to engender Conceptual Changes about Wave Motion*	2001	MEd
Jooste, J.P.	*Design Issues for the Support of Multimedia Educational Software on a LAN*	1996	MSc
Kemp, R.	*Die Verwantskap tussen Visualisering in Chemie en Multimedia-Onderrig*	2000	MSc
Schoeman S.	*Instructional Design for Distance Music Education*	1999	DMus
Steenekamp, J.H.	*Towards Guidelines for Tertiary Distance Education Courseware Design: a Textlinguistic Perspective*	1999	MA
Strehler, Anne	*Care of the Ventilated Patient: a CAI Program for Nursing Students*	1994	MEd
van Biljon, J.A.	*An Intelligent Computer-aided Education System Aimed at the Teaching and Learning of Mathematics according to the Problem-based Learning Approach*	1998	MSc

Table 1.1 - Related research projects

From the topics listed in the table it is clear that this research project is relevant, but unique since none or the above research projects was concerned with a specific design model. Although Strehler's Computer-assisted Instruction program (CAI program) was also developed for students in the health sciences, it was aimed at nurses, whereas the CAI program in this study was developed for dietetics students.

1.5 Research Methodology

1.5.1 Type of research

The study continues with a literature survey on the relationship between learning theory, curriculum theory, instructional design theory and the instructional design process. Merrill's Model of Instructional Design is a particular focus.

The main part of the study is concerned with the practical implications of using Merrill's Model of Instructional Design and the formative evaluation of a multimedia instructional program designed on this model.

Reeves (2000) identifies six different goals for Instructional Technology Research: Theoretical, Empirical, Interpretivist, Postmodern, Development and Action Goals. This research falls into the Development Research category. Van den Akker (1999) identifies a significant characteristic of development research as focusing on "complex, innovative tasks for which only very few validated principles are available to structure and support design and development activities" (Reeves, 2002, p.7).

The study has a predominantly qualitative character since the findings are based on observations, a structured questionnaire, open questions and a group discussion.

1.5.2 Research schedule and responsibilities

	Activity	Date	Team member
1	Proposal to TLO	Sept 2000	Nordhoff, Wenhold
2	Literature review	February 2001 - October 2001	Nordhoff
3	Course content outline	February 2001 - June 2001	Wenhold
4	Design and develop prototype tutorial	July 2001 - October 2001	Wolmarans et al.
5	Formative evaluation	29 October 2001	Nordhoff, Wenhold and Wolmarans
6	Writing research essay	November 2001 - April 2002	Nordhoff
7	Final research essay	April 2002	Nordhoff

Table 1.2 - Research schedule and responsibilities

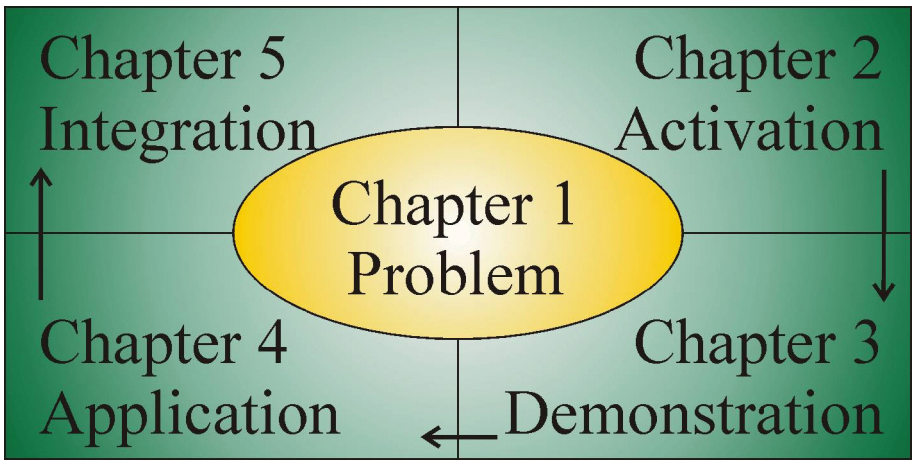
1.6 Limitations of the Study

The multimedia Anthropometry tutorial was developed for third-year dietetics students at the University of Pretoria, a very homogeneous group. The group members are all female, between 20 and 30 years old, mostly Afrikaans-speaking and fairly computer literate. The prototype was only tested by representatives of this group.

Although the multimedia program has the potential to become a valuable training resource for a range of health workers, testing of its suitability for other groups of health workers was not part of this study. The suitability of Merrill's Model for developing courseware in other educational fields was not investigated.

1.7 Overview of the Research Essay

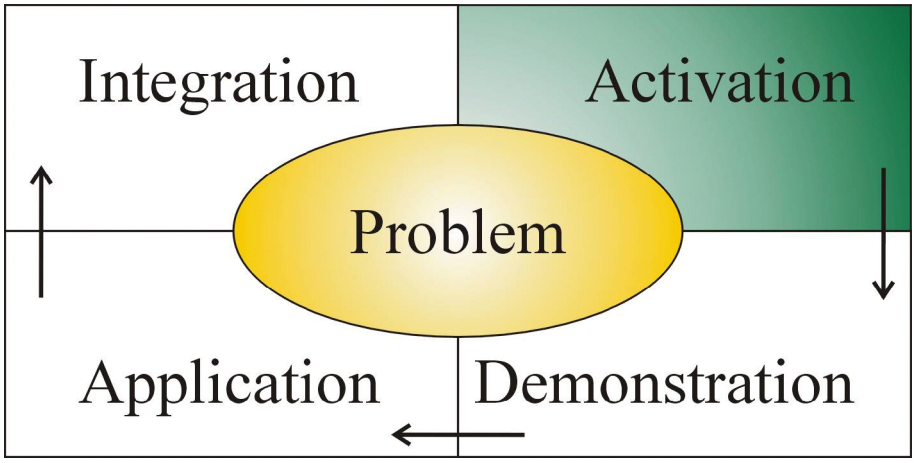
This research essay consists of five chapters. The five elements in Merrill's Model of Instructional Design are the titles of the chapters.



Chapter 1	**Problem**	The introductory chapter provides the background to the research problem.
Chapter 2	**Activation**	This chapter reviews the literature of learning theory, curriculum theory, instructional design theory and the instructional design process, and looks at the relation between these theories. Particular attention is given to Merrill's Model of Instructional Design.
Chapter 3	**Demonstration**	This chapter describes the process of developing a computer-based Anthropometry tutorial for senior dietetics students.
Chapter 4	**Application**	This chapter discussed the formative evaluation of the tutorial program.
Chapter 5	**Integration**	The final chapter draws conclusions and makes recommendations for further research.

Table 1.3 - Overview of research essay

Chapter 2 - Activation



"Learning is facilitated when the learner is provided with relevant experience that can be used as a foundation for the new knowledge."

(Merrill, 2001, p. 5)

Chapter 2 - Activation

2.1 Introduction

This chapter provides an overview and a brief summary of learning theory, curriculum theory, instructional design theory and the instructional design process.

Merrill's design theory, First Principles of Instruction, is emphasised as well as the following aspects:

- the value of using a real-life problems in the instructional event
- the importance of activation of existing knowledge of the learner
- the role of demonstration
- guided problem solving and
- the integration of new knowledge with existing knowledge.

2.2 Background

Education and training worldwide is changing from standardisation to customisation; from educator-centred or teacher-centred to learner-centred, from memorisation to understanding. Learners are expected to direct their own learning, pace their learning activities and to become lifelong learners. Companies need "employees who can take initiative, think critically, and solve problems" (Reigeluth, 1999, p. 18).

This requires a paradigm shift in education and instruction. Educators become facilitators and only one of many resources available to learners. It also implies that educators have to change their method of instruction. A multitude of instructional design theories are being developed to assist educators in their new roles.

> Learning-focused instructional design theory must offer guidelines for the design of learning environments that provide appropriate combinations of challenge and guidance, empowerment and support, self-direction and structure(Reigeluth, 1999, p. 21)

Instructional design theories take into account the findings of both learning theories and curriculum theory. These three theories in turn influence the actual design process. Because of the close relationship between instructional design theory, learning theory, curriculum theory and the design process, instructional designers should be familiar with all four theories.

This section is structured as shown in Figure 2.1

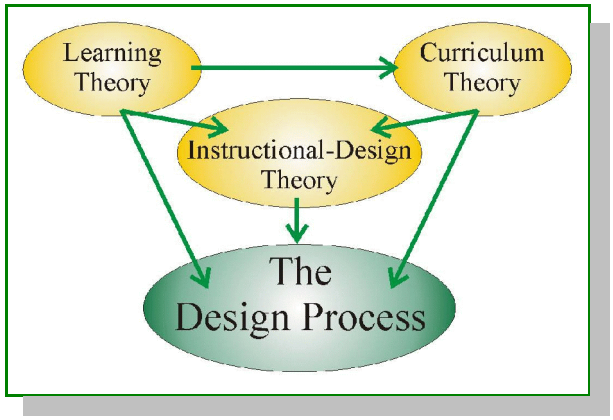
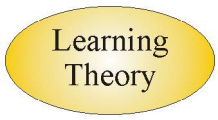


Figure 2.1 - Theories

2.3 Learning Theory



Learning theories are one aspect of cognitive psychology; they describe how learning takes place. Reigeluth postulates,

> Three views of learning have emerged during the past 100 years of research on learning: learning as response strengthening, learning as knowledge acquisition, and learning as knowledge construction. (Reigeluth, 1999, p. 143)

2.3.1 Behaviourism

The first view of learning, learning as response strengthening, is also known as behaviourism. Although the concept of behaviourism can be traced back to the Greek philosopher, Aristotle, the term behaviourism was coined by John Watson and most behaviourist theories were developed in the late 19th and the first half of the 20th century. Behaviourist theories are based on studies of animal learning in laboratory settings. The behaviourist sees learning as a change in behaviour and is concerned with stimulus-response events. Key figures in the development of behaviourist theories are Ivan Pavlov, Edward Thorndike, John Watson, Lev Vygotsky (in the field of social learning) and Burrhus Skinner, whose influence is still strongly felt in education. Benjamin Bloom's Taxonomy of Educational Objectives and Robert Gagné's taxonomy of learning are both founded on behavioural psychology.

These theories have implications for instructional designers. Programs are designed to be linear, content is divided into small portions and the learners receive immediate feedback for each active response to a stimulus. Repetition and reinforcement are important elements of any instructional activity.

2.3.2 Cognitivism

The second view, learning as knowledge acquisition or reception learning, can also be traced back to the ancient Greeks, but the main theories were developed between 1950 and 1980. Cognitivist theories are based on studies done on humans in laboratory settings and argue that learning occurs when new information is placed in the long-term memory of the learner. "The primary focus of the cognitive approach to learning is how processing affects the understanding and retention of information" (Dills & Romiszowski, 1997, p. 634). The best-known cognitivists are Jean Piaget, Jerome Bruner and David Ausubel.

In instructional design cognitivism places emphasis on rehearsal and repetition so that the learner can better organise and remember the information.

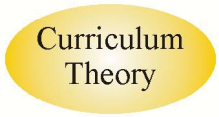
2.3.3 Constructivism

The third view, learning as knowledge construction, is also known as constructivism or discovery learning. Although Frederic Bartlett pioneered the constructivist approach in 1932, most constructivist learning theories were only developed over the last 20 years and are based on studies done of human learning in realistic settings. Constructivist theories assume that knowledge is constructed by the learner. Advocates of constructivist theories are Howard Gardener, David Jonassen and M. David Merrill.

Instructional design therefore provides real-world, case-based learning environments with authentic tasks and enables knowledge construction through the use of branched rather than linear design. Mergel gives a balanced definition of the concept,

> Constructivism promotes a more open-ended learning experience where methods and results of learning are not easily measured and may not be the same for each learner. (Mergel, 1998, online)

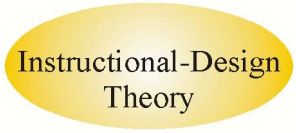
2.4 Curriculum Theory



Curriculum theories are concerned with the content of instruction, i.e. with 'what to teach'. Content is closely linked to the goal of the instruction, with defined outcomes to be achieved and identified skills to be mastered. Curriculum theory explores areas such as the social construction of knowledge, the influence of technology on learning and the effect of politics on curricula. It examines ideological orientations towards the curriculum and provides guidelines for curriculum design and development. Curriculum theory implies interaction with and influences on a range of factors,

> The character of curriculum shapes and is shaped by its external relationships with knowledge, perspectives, and practices in other educational domains: administration, supervision, foundations, policy studies, evaluation, research methodology, subject areas, educational levels, teaching or instruction, special education, educational psychology, and so on. (Schubert, 1986, p. 35)

2.5 Instructional Design Theory



The centrality of adapted and customised instruction is clear from Reigeluth's statement,

> An instructional design theory is a theory that offers explicit guidance on how to better help people learn and develop. The kinds of learning and development may include cognitive, emotional, social, physical, and spiritual learning. (Reigeluth, 1999, p. 5)

Instructional design theories are goal-oriented and identify methods of instruction for specific situations. These methods have sets of components, which makes them flexible and adaptable, as noted by Gros,

> Instructional design models have the ambition to provide a link between learning theories and the practice of building instructional systems. (Gros et al. from de Lisle, 1997, online).

Some instructional design theories are:

Cognitive Education, Multiple Approaches to Understanding, Teaching and Learning for Understanding, Open Learning Environments, Constructivist Learning, Learning by Doing, Collaborative Problem Solving, Problem-based Learning (PBL) and Merrill's First Principles of Instruction.

These theories are not mutually exclusive, but overlap and often have a number of common elements. Merrill's Model of Instructional Design was used for the Anthropometry tutorial, the subject of this study, and will be discussed in detail below.

2.5.1 Merrill's Model

One of the major theorists in the Instructional Design field is M. David Merrill, Professor in the Department of Instructional Technology at Utah State University (Viljoen, 2002, online).

Merrill divides the instructional event into four phases which he calls **Activation**, **Demonstration**, **Application** and **Integration**. Central to this instructional model is a real-life **Problem**.

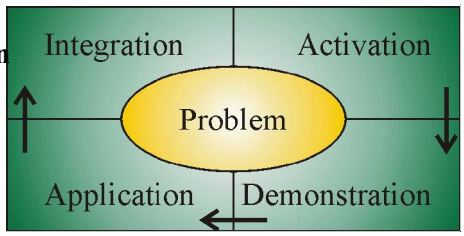


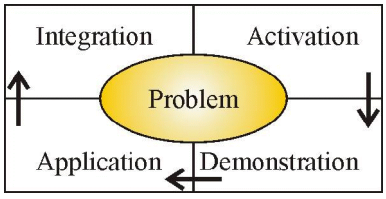
Figure 2.2 - Merrill's Model

Merrill's Model is consistent with the six principles from the biology of learning (Kovalik & McGeehan - 1999, as quoted by Merrill, 1997, p. 1),

1. Emotions are the gatekeepers to learning.
2. Intelligence is a function of experience.
3. Humans in all cultures use multiple intelligences to solve problems and to create products.
4. The brain's search for meaning is a search for meaningful patterns.
5. Learning is the acquisition of useful mental programs.
6. Personality – one's basic temperament – affects how a learner takes in information, organizes and uses it, makes decisions about it, and orients him / herself with respect to the world and other learners.

a. Problem

Problem-based learning (PBL) is perceived by some as the most exciting approach to education and learning, which has been developed in the last thirty years. The term PBL is used to describe a variety of projects, from research and solving case studies, to guided design and engineering design projects. Noteworthy is the fact that

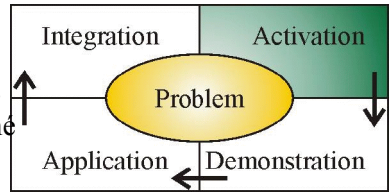


> PBL is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving proficiency, self-directed learning strategies, and team participation skills. The process replicates the commonly used systemic approach to resolving problems or meeting challenges that are encountered in life and career.
>
> (Maricopa Centre for Learning and Instruction, 2001, online)

Recent research in cognitive psychology has shown that learners who are actively involved in solving real-life, authentic problems learn better. Confronting learners with a real-life problem should activate several cognitive processes, one of which is the search for relevant information and concepts in their long-term memories, i.e. existing knowledge is activated. Merrill explores several elements in the process of PBL,

> Learning to solve problems involves four levels of instruction: the action-level, the operation-level, the task-level and the problem-level. Too much instruction is limited to the action or operation level and does not involve the student in the more integrative task or problem levels. (Merrill, 2001, p. 5)

b. Activation



The importance of activation of existing knowledge has been addressed by a number of educational psychologists. During Merrill's **Activation** phase prior knowledge (or experience) is recalled and emotions are triggered. This corresponds to Gagné first three events of instruction: stimulating to gain attention, informing learners of the objectives of the instruction and reminding learners of relevant previously learned material.

Not only pre-knowledge should be activated during this phase, but mental models as well. If these mental models consist of misconceptions, the instructional process could modify them.

The activation of existing knowledge takes place in a number of different ways. These depend on the instructional approach, the cultural background of the learners, their emotional state and the planned outcomes of the instructional event.

Knowledge and understanding

Knowledge exists in three major forms: images, concepts and prepositions, according to Dills & Romiszowski (1997, p. 664). Knowledge can be activated by external stimuli or internally by mental operations or self-instructions. Reigeluth points out that

> Understanding a topic is a matter of being able to think and act creatively and competently with what one knows about the topic. (Reigeluth, 1999, p. 97)

The learners in any classroom or instructional situation have a wide variety of past experiences. They also have different attitudes towards the instructional and learning process; some learners expect to be taught, while others are willing to direct their own learning.

Ausubel confirms the importance of Merrill's emphasis on pre-knowledge,

> If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.
> (Ausubel in Dills & Romiszowski, 1997, p. 403)

This is also confirmed by Anderson, Adams & Bruce and Rummelhart & Ortony,

> Research on human learning indicates that students will learn more if they can relate new information to what they already know.
> (as quoted in Alessi & Trollip, 1997, p. 22)

It is therefore important to activate the student's relevant existing knowledge. This can be done in a number of different ways: using an introduction or providing learning objectives, giving a pretest or confronting the learner with a problem to be solved.

Introduction and learning objectives or outcomes

Learning objectives, goals or outcomes can be used to challenge, motivate and guide learners and to assist them to structure their own learning experience. They also provide the opportunity to activate the existing knowledge and set the scene for the instruction that is to follow. Hajre-Chapman sees a broader application of the learning objectives,

> I use them for accountability for myself, and for focussing, orientating, motivation and interest. (Hajre-Chapman, ITFORUM, 19 Feb. 2001)

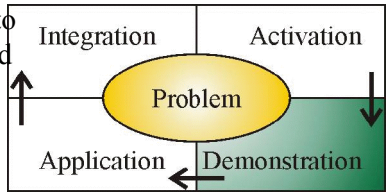
Research has shown, however, that introductions and learning objectives are seldom read by learners if they are not forced to do so, as documented by Alan Carr,

> In my own work, I have found that undergraduate students ignore the objectives page, and jump straight in to the assignments. Even at the end of the course, less than 5% of these students had looked at the objectives.
> (Carr, ITFORUM, 16 Feb. 2001)

Pretest

Pretests are used to determine the readiness of a learners for the instruction that is to follow and can be useful to prevent the learners repeating an instructional sequence of material they already know. As for computer-based tutorials, Alessi cautions, "it is not good for a pretest to be built **into** a tutorial. It is better for a pretest to be in a separate program" (Alessi & Trollip, 1997, p. 22). Pretests should therefore be used with care since they can negatively influence the attitude of the learners towards the new material.

c. Demonstration



The main goal of any instructional event is to expose learners to new knowledge and skills and to "bring about new learning and new capabilities" (Lefrancois, 1997, p. 193).

During the **Demonstration** phase the instructor presents new material and demonstrates new skills.

Reigeluth defines a demonstration as

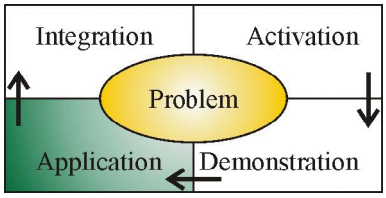
> a carefully prepared presentation that shows how to perform an act or use a procedure; accompanied by appropriate oral and visual explanations and illustrations; frequently accompanied by questions. (Reigeluth, 1999, p. 97)

Demonstration focuses the learner's attention on relevant information and promotes the development of appropriate mental models; it shows actions in a certain sequence, can simplify complex tasks and facilitate learning.

According to Merrill learning is facilitated when

> the learner is shown rather than told, is shown multiple representations and is directed to explicitly compare alternative representations. (Merrill, 2001, p. 6)

d. Application



The purpose of a practice phase in the instructional event is to provide an opportunity for learners to develop proficiency and become experts. Merrill's application phase combines Gagné's elicit learner performance that uses new learning and provide feedback about learning events.

During the **Application** phase cognitive processes come into play; there is a search for meaningful patterns and mental programmes are formed. The link between recalled learning and repeat experiences is clear,

> The only way we remember what we learned is by having similar experiences that trigger our memories. (Schank et al. in Reigeluth, 1999, p.166)

The importance of guided problem solving

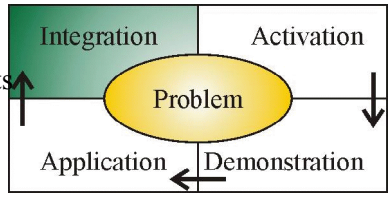
Woods outlines the process of skills development,

> To develop skill requires that the educator explicitly takes the skill apart, asks the learners to try it, figuratively holds up a mirror so that the learners can see how they did the skill, describe potential target skills, and then give them practice + feedback, practice + feedback until they know they have the skill.
> (Woods, 1994, p. 2)

Merrill points out that the process of skills acquisition involves error recognition,

> Making errors is a natural consequence of problem solving. Most learners learn from the errors they make, especially when they are shown how to recognize the error, how to recover from the error, and how to avoid the error in the future.
> (Merrill, 2001, p. 7)

e. Integration



Most instructional events end with an assessment phase. During this phase learners have to prove that they have acquired new knowledge and skills. Gagné's assessment events are, evaluate the learner's performance and arrange for future practice to aid retention and generalisation. Merrill calls this the **Integration** phase during which the learner gets the opportunity to prove new capabilities and show newly acquired skills. The integration phase uses the higher order thinking skills in Bloom's Taxonomy, Analysis, Synthesis and Evaluation.

f. Summary of Merrill's Model

Merrill says that

> Learning is facilitated when the learner is engaged in a real-world problem, when new knowledge (and skills) build on the learner's exciting knowledge (and skills), when new knowledge is demonstrated to the learner, when new knowledge is applied by the learner and when new knowledge is integrated into the learner's world. (Merrill, 2001, p. 3)

2.6 Instructional Design Process

The instructional design process is concerned with the processes used to design or plan the instruction. There are a number of instructional design models, some more flexible than others. In all models evaluation plays an important role, but in some it only occurs at the end. Others place more emphasis on continuous evaluation and use it at every stage of the developmental process.

Design models include:

2.6.1 The ADDIE design model

The most familiar design model is the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model.

Depending on the situation, the five steps of this model are reduced to three or even expanded to seventeen.

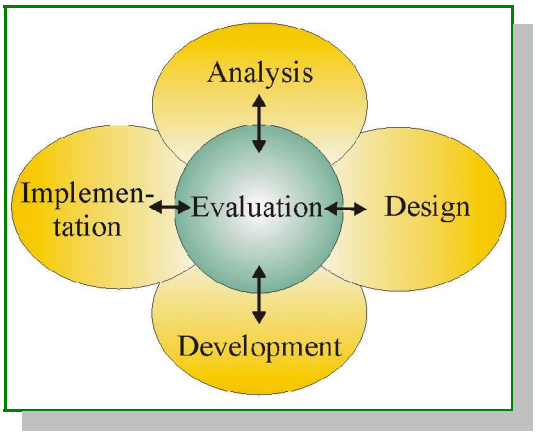


Figure 2.2 - ADDIE model

2.6.2 The DADI model

The DADI (Definition, Architecture, Design and Implementation) design model is similar to the waterfall model (discussed below), but differs in that

> You cannot proceed to the next step until the previous step is understood. You may however, return to the previous section whenever changes require. (Shorts, 1996, online)

The phases in the DADI model are:

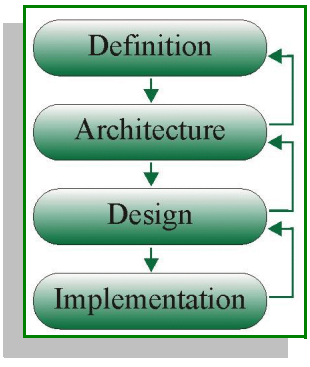


Figure 2.3 - DADI model

Definition

During the definition phase, objectives are defined, logistics examined and the scope and depth, the budget and time frame are determined.

Architecture

During the architecture phase, the major content areas are identified and decisions about navigation and media types are made.

Design

The design phase determines what the product will actually look like.

Implementation

In the implementation phase, content is subjugated to a process, as stated by Pajak, "This stage is strictly: Build, Test, Fix, Repeat."

(Pajak, accessed 2002, online)

2.6.3 The object-oriented model

Shorts explains the origins of this model, "This model comes from the push in the software industry to move away from older coding approaches towards an object-oriented approach."
(Shorts, 1996, online)

The phases in the object-oriented model are:

Object-oriented analysis

Its presence in the model preempts an object- oriented perspective.

User and Task Analysis

The user and the task are analysed and the scope of the project is determined.

Design User's Conceptional Model

The concepts required during the use of the program are developed.

Design Information Presentation

During this phase the manner in which information will be presented is decided.

Design Interaction and Control Mechanisms

The controls for the program are developed during this phase.

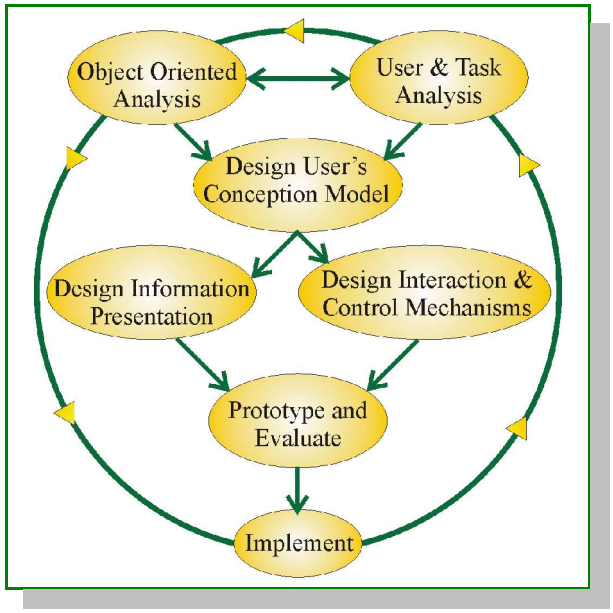


Figure 2.4 - Object-oriented model

Prototype and Evaluate

The prototype is developed and tested during this phase.

Implement

The developed and tested object piece is combined with the rest of the program.

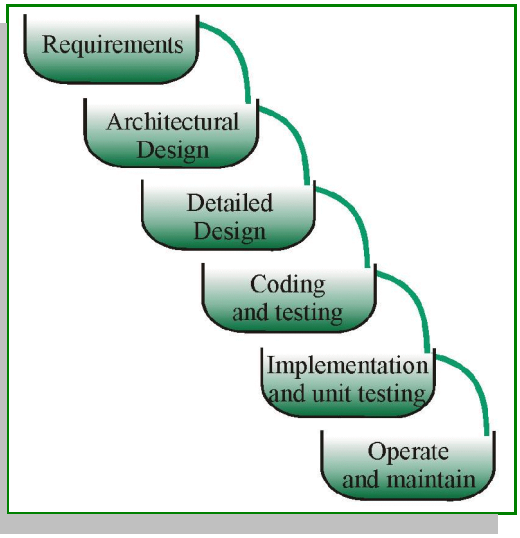


Figure 2.5 - Waterfall design model

2.6.4 The waterfall model

The waterfall model was derived from an engineering model and makes use of a strictly linear approach. The idea is that the outputs of one stage flow into the next stage. This implies that each step has to be completed before the next step can be started. The rigidity of this model is not suited to all applications, but it is easier to manage than more flexible models.

Some developers add continuous evaluation to this model, using it like the "snakes and ladders" in the game, either to skip steps or slide back to the start.

2.7 Conclusion

This chapter reviewed the difference between instructional design theory, learning theory, the instructional design process and curriculum theory. Some instructional design process models and their components were briefly discussed.

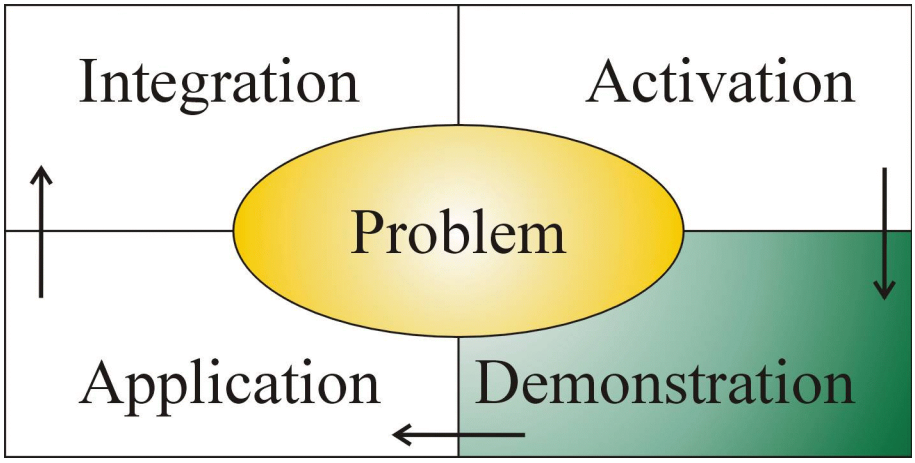
Instructional design theories are not discrete, isolated theories. It is clear that they overlap and some are more suitable for a specific course than others. They are also strongly influenced by learning and curriculum theories. Before deciding on the application of a specific design theory, instructional designers have to become familiar with the curriculum of the course and decide which learning theories will be most appropriate for the planned instructional event. Reigeluth (Reigeluth, p. 55) proposes that the following elements should be considered before deciding on an instructional design model:

- Focus of learning (interdisciplinary, topic, domain or problem)
- Type of learning (memorisation, comprehending, skills application)
- Control of learning (educator-centred or learner-centred)
- Grouping for learning (individual, pairs, teams or larger groups)
- Interactions for learning (learner-educator, learner-learner, learner-tools, learner information, learner-environment)
- Support for learning (cognitive and/or emotional)

Merrill's Model was found to be suitable for the Anthropometry tutorial, since the focus of learning is on problem solving and students should understand and practise skills application. The support for learning is cognitive rather than emotional, students will learn individually and control of learning will be shared between educator and student.

Once an instructional model has been chosen, the designer has to decide on the most suitable design process model. The ADDIE model was used for the development of the Anthropometry tutorial, since this is the model used by Telematic Learning and Education Innovation at the University of Pretoria.

Chapter 3 - Demonstration



"Learning is facilitated when the learner is shown rather than told."
(Merrill, 2001, p. 6)

Chapter 3 – Demonstration

3.1 Introduction

This chapter provides an overview of the design process of the multimedia program for Nutritional Assessment. A summary of the different phases in Merrill's Model (Chapter 2, 2.5.1) is given as well as an analysis of the activities in the first three stages (Analysis, Design and Development) of the ADDIE model for this particular multimedia program. As this research project ended with the formative evaluation of the program, the implementation and summative evaluation are not part of this research document.

3.2 Background Information

Dietetics students enrolled at the University of Pretoria do a compulsory four-module course on Nutritional Assessment in their third year of undergraduate study. The modules, Nutritional Assessment 311 (NTA 311), Nutritional Assessment 312 (NTA 312), Nutritional Assessment 321(NTA 321) and Nutritional Assessment 322 (NTA 322) are currently presented in the traditional manner with three lectures and one two-hour practical session per week.

The Faculty of Health Sciences uses a problem-based learning (PBL) approach. Dietetics students enrolled for the Nutritional Assessment modules typically get a case study from which they have to extract the necessary information to make a nutritional diagnosis. For this diagnosis, they have to consult a variety of resources and reference manuals, e.g. Weight for Height tables, Body Mass Index tables, Nomograms. Some of this reference material is updated regularly by large pharmaceutical companies and also by institutions like the World Health Organisation (WHO). Globalisation and the increasing access to the Internet makes it worthwhile for these institutions to place the resources on the Internet rather than distribute them in printed form.

Ms. Friede Wenhold, the lecturer of the Nutritional Assessment modules, approached the researcher to discuss the possibility of producing a multimedia tutorial on CD for the Nutritional Assessment modules to assist the students. It was decided to develop a multimedia program for only one module, Anthropometry, and to test it first before adding the other three modules, Biochemistry, Clinical Assessment and Dietary Assessment.

To ensure the future of the program, the project was registered with Telematic Learning and Education Innovation (TLEI) at the University of Pretoria. The application (Appendix A) for funding was accepted and a team put together for the development of the program.

Merrill's Model of Instructional Design (Merrill, 2001, p.2) was used for the design and development of the multimedia tutorial on Anthropometry. Third-year dietetic students participated in the formative evaluation of the prototype.

3.3 The Team

Alessi and Trollip encourage a team-oriented approach towards designing instructional courseware. “In our experience, and that of other designers, courseware is always better when several people collaborate.” (Alessi & Trollip, 1991, p.245)

This approach is also followed at Telematic Learning and Education Innovation (TLEI) at the University of Pretoria.

For this project the team consisted of the following people:

- Ms Anne Strehler, project leader at TLEI at the University of Pretoria.
- Ms Friede Wenhold, subject matter expert and lecturer in the Department Human Nutrition in the Faculty of Health Sciences.
- Ms Henriëtte Wolmarans, designer at Telematic Learning and Education Innovation at the University of Pretoria.
- Ms Helga Nordhoff, educational researcher and MEd(CIE) student.
- Graphic artists, photographers and models.
- All third-year dietetic students for the formative evaluation.
- Dr Hermi Boraine, statistician from the Department of Statistics at the University of Pretoria.

3.4 The Design Process

The ADDIE model was used for the design process of this program.

At Telematic Learning and Education Innovation the five steps of the ADDIE model are subdivided into 17 steps:

1.	**Analysis**	Exploratory Phase Broad Needs Analysis Show Target and Content Analysis Project Proposal Service Level Agreement Training In-depth Analysis	1. 2. 3. 4. 5. 6. 7. 8.
2.	**Design**	Prototype Demo of Prototype Design	9. 10. 11.
3.	**Develop**	Development	12.
4. 5.	**Evaluate, Implement** and **Evaluate**	Formative Evaluation Summative Evaluation Implementation Student Feedback Review & Maintenance	13. 14. 15. 16. 17.

Table 3.1 - The ADDIE model as used by TLEI

3.4.1 Analysis

Target population

Traditionally dietitians in South Africa are female; there are only a few male dietitians. From a survey done of 211 dietitians by Friede Wenhold (1993, p. 94-95) for her Master's degree in Dietetics, the following facts have been documented:

Gender	99% female
Age	41% under 30 47% between 31 - 44 12% older than 45 years
Highest Qualification	50% 3-year or 4-year degree + diploma 36 % 4-year degree + diploma or honours 12% M or PhD/DSc
Experience	33% had less than 4 years experience 33% had 5 - 9 years experience 21% had 10 - 14 years experience 13% had more than 14 years experience
Period since last qualification	33% less than 4 years 28% between 5 - 9 years 20% between 10 - 14 years 19% more than 14 years

Table 3.2 - Dietitians in South Africa

This situation has not changed at the University of Pretoria. Dietetics students are still only female, mostly Afrikaans-speaking and fall into the age group, 18 - 22 years.

It was decided to use the whole class of third-year dietetics students for the formative evaluation of the program. Twenty-five female students were enrolled for the Nutritional Assessment course in 2001. Most of them were Afrikaans-speaking and it was assumed that they are computer literate since a computer literacy course has to be completed by all students who enrol at the University of Pretoria. Most South African universities currently have compulsory computer literacy courses for all their students. It is therefore acceptable to expect students to be fairly computer literate.

It was planned that by the time the program would be ready for this evaluation, the students would have completed the traditional paper and lecture-based course in dietetics and therefore should have become familiar with the content of the course work. This would enable them to provide feedback on navigational and aesthetic elements of the program, as well as on the content, the possible value of the program for the course, and its use and implementation in the following year for the modules they had just completed.

3.4.2 Design

After a workshop titled 'Does your Instruction rate 5 Stars?' presented by David Merrill, at the University of Pretoria in February 2001, the researcher and design team decided to use Merrill's Model for the development of the Anthropometry tutorial. Merrill's approach of putting a real-life problem into the centre of the instructional episode is particularly suited to the problem-based learning approach followed in the Faculty of Health Sciences.

Merrill clearly states that his model is not appropriate for courseware consisting of reference material, isolated facts or psychomotor skills, nor for receptive or exploratory courseware. As an evaluation method, Merrill awards one Star to an instructional program for each 'yes' to the following five questions:

1. Is there a Problem to solve?
2. Is there Activation of existing knowledge?
3. Is there Demonstration?
4. Is there Application?
5. Is there Integration of the new knowledge?

He does not award Stars to tell-and-ask instruction.

For effective and efficient instruction, Merrill distinguishes between the following teaching parts (Merrill, 2001, Workshop notes, p.13):

Tell	Show	Ask	Do
part name & part description	entity portrayal & part portrayal	part name & part description	point to portrayal

Table 3.3 - Tell, Show, Ask and Do

The Tell and Show activities are instructor activities and fall into the Activation and Demonstration phases of the instructional event. The Ask and Do activities are learner activities and fall into the Application and Integration phases. The table provides an overview of the activities associated with Tell, Show, Ask and Do.

Instructor / Lecturer activity		Student activity	
Tell	Tell is associated with the naming of parts, a description process or a technique.	**Ask**	Ask the student to name a part or to describe a process.
Show	Show is the portrayal of an entity or the demonstration of a skill or technique. The 'show' should help the student to identify the different steps in a technique.	**Do**	Do provides an opportunity for the student to practise the newly acquired skills. The educator should be available to assist the student during this phase, but should gradually withdraw the support until the student is able to perform required activities/tasks without assistance.

Table 3.4 - Lecturer and student activities

a. The Nutritional Assessment course

The Nutritional Assessment course as taught in the division Human Nutrition at the University of Pretoria is divided into four sections: Anthropometry, Biochemistry, Clinical and Dietary Assessment. An overview of the course is given in the figure below.

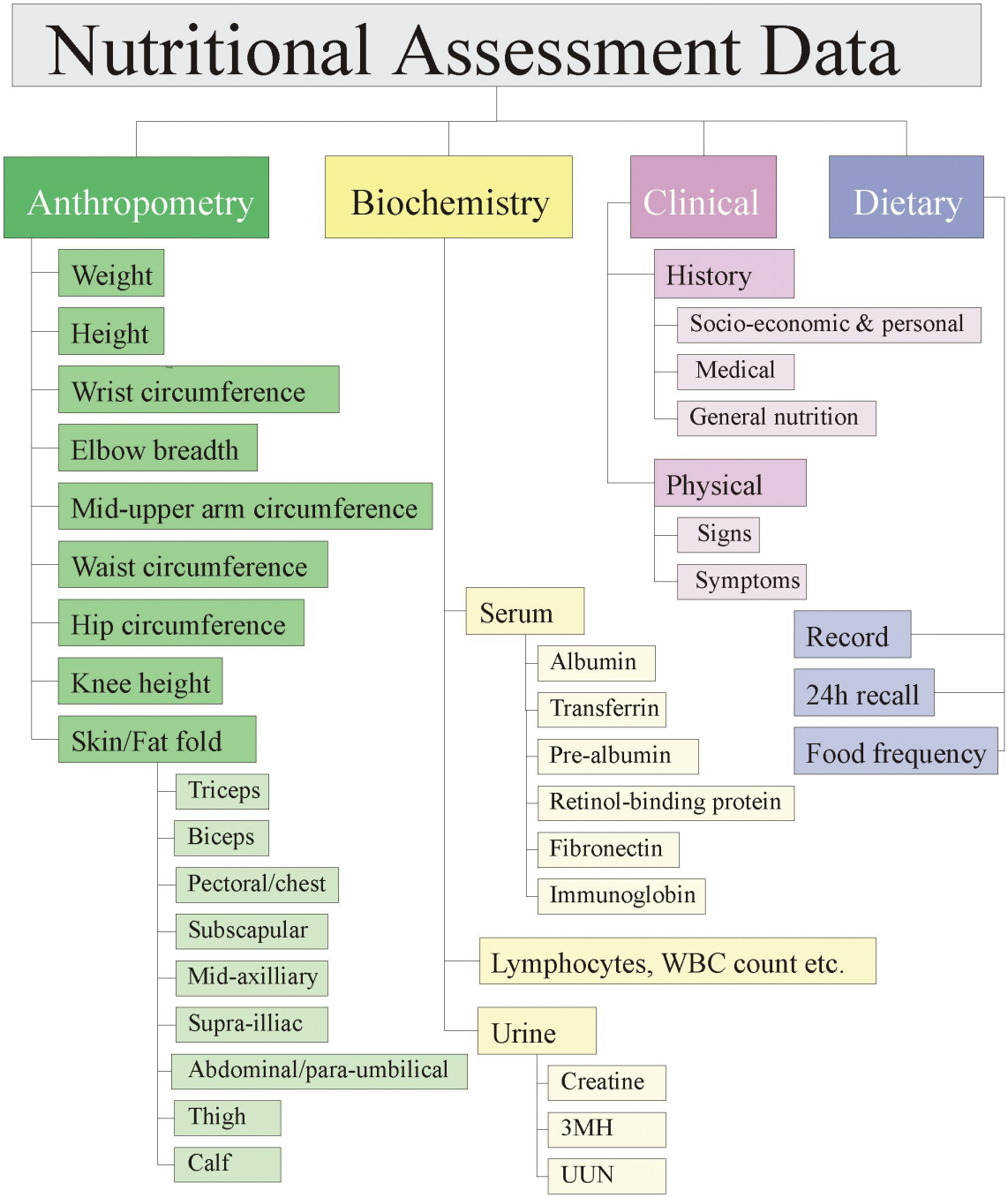


Figure 3.1 - Overview of the Nutritional Assessment course

Ms Friede Wenhold organised the content of the Anthropometry course in a table under the headings: Tell, Show, Ask, and Do (Appendix B).

An example, the section of the table for *Anthropometry -> Whole Body -> Infants and Children -> Waterlow classification*, is shown in the table below:

Tell	**Show**	**Ask**	**Do**
Wasting Weight for height Indices and indicators * Percentiles * % of median * Z-score Cut-offs	Refer back to weight and height Difference between wasting and stunting: (Photo: McLaren p11); Drawing: Waterlow p189 (fig 13.1) Nabarro wall chart = "Thinness chart" (Jeliffe & Jeliffe p19; King & Burgess p188)	Guided calculations Guided interpretation of limited given data	Paper case study: On own
Stunting Height for age Indices and indicators * Percentiles * % of median * Z-score Cut-offs	CDC growth charts (www.cdc.gov/growthcharts) Demonstrate: How to plot on growth charts How to interpret data Wellcome Trust CD	Guided calculations Guided interpretation of limited given data	Paper case study: On own

Table 3.5 - Tell, Show, Ask and Do for the Anthropometry course

Ms Henriëtte Wolmarans used the table as a guide during the design process of the program. She knew that topics listed under Tell had to become part of the reference section. Topics listed under Show were part of the Demonstration phase and should be integrated in the tutorials. Topics under Ask and Do are student activities and had to be placed into the guided problem-solving section or the case study section.

b. Merrill's four phases and the Problem

The four phases of an instructional event according to Merrill are shown in figure 3.2. It is clear that the **Problem** is in the centre of events. Merrill usually starts with **Activation**, then goes to **Demonstration**, **Application** and **Integration**.

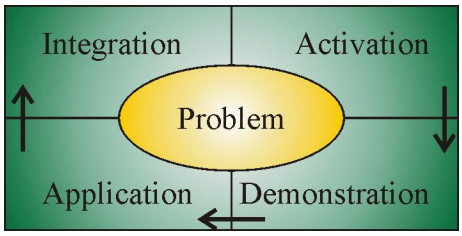


Figure 3.2 - The four phases of instruction

Table 3.6 provides a graphic summary of what happens in the Anthropometry course in each of Merrill's four phases.

Integration Integration of the new knowledge with the existing knowledge is achieved if the student gets the opportunity and time to practise and apply the newly developed skills. Dietetics students get the opportunity to practise the anthropometric measurement techniques on each other during the practical sessions in the 'skills laboratory' before they are allowed to use their skills in a clinical situation. A computer program is not suitable to test the integration of a physical skill.	**Activation** The first phase of the instructional event is the activation of existing knowledge. This is to enable the learner to activate appropriate, existing mental models onto which the new knowledge can be built. According to the lecturer, the content of the anthropometry course is so new and different that there is no previous knowledge that could be activated by a pretest.
The Problem The case studies given to the students once they have completed the theoretical part of the paper-based course are suitable problems for this tutorial program. These case studies typically describe a patient and relevant nutritional problems, as well as circumstances and any lifestyle problems. The student is also provided with some data (measurements, etc.) and clinical information about the patient. She then has to make a nutritional assessment of the patient.	
Application Once the dietetic student knows how to take anthropometric measurements, she has to practise interpreting the results of these measurements. This requires higher-order thinking skills and part of the challenge of the Nutritional Assessment course is the development of these higher-order thinking skills. The student is supposed to read through a given case study, then use the information to make calculations and write a short summary of the nutritional assessment of the patient mentioned in the case.	**Demonstration** In the Anthropometry course the students have to learn a large number of physical skills in taking anthropometric measurements using special equipment. Demonstration in this case is of great value, because the instructor can show the correct method and focus the attention of the student on important information. Many photos and a few videos were used in the program to demonstrate the different techniques the students have to acquire.

Table 3.6 - Merrill's instructional phases for the Anthropometry course

3.4.3 Development of the program

The development of the program was done by Ms Henriëtte Wolmarans, an instructional designer at Telematic Learning and Education Innovation. She was assisted by graphic designer Marcel Hoffmann.

a. Colour scheme

The colour scheme of the tutorial is very feminine; different shades of green are used throughout the tutorial. Occasionally a light brown is used for contrast. The first screen of the prototype is shown in the figure below.

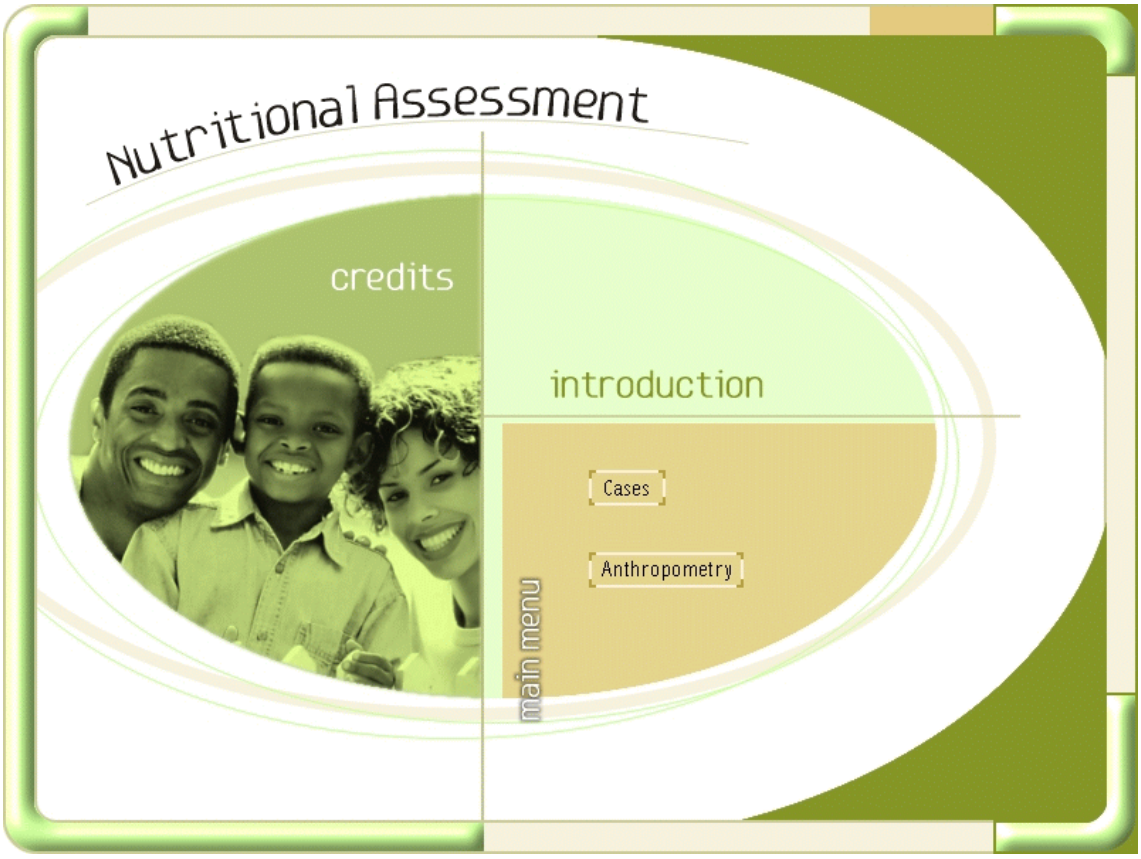


Figure 3.3 - The first screen of the Anthropometry tutorial

b. Structure

The program consists of four main sections: case-studies, an Anthropometry tutorial, a measuring tutorial and a resource collection consisting of tables and graphs which are needed by dietitians to interpret the anthropometric measurements. Links are provided to the MS-WINDOWS programs, NotePad and Calculator.

c. Case studies

The prototype had two case studies (a child and an adult) for which the students could make a nutritional assessment.

d. Tutorial

The Anthropometry tutorial is a basic, text-based tutorial, adopted from an online tutorial designed by Bill Bender and Sandy Remancus (Bender et.al. 2001, online). It follows the classical structure of a tutorial.

e. Measuring Tutorial

The measuring tutorial uses photographs and a few videos to show measuring equipment and to demonstrate measuring techniques. (Figure 3.4)

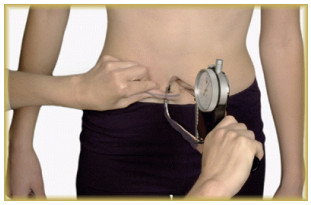


Figure 3.4 - Photo showing how to measure abdominal skinfold thickness

f. Resource collection

An extensive resource collection consisting of numerous tables as well as formulae is part of the program.

g. Sound

No sound was used in the program. Sound was not seen as an important element of the program in the early stages of development since it is easy to add later and the designers were under severe time pressure to get a prototype ready for the set date of the evaluation by the students.

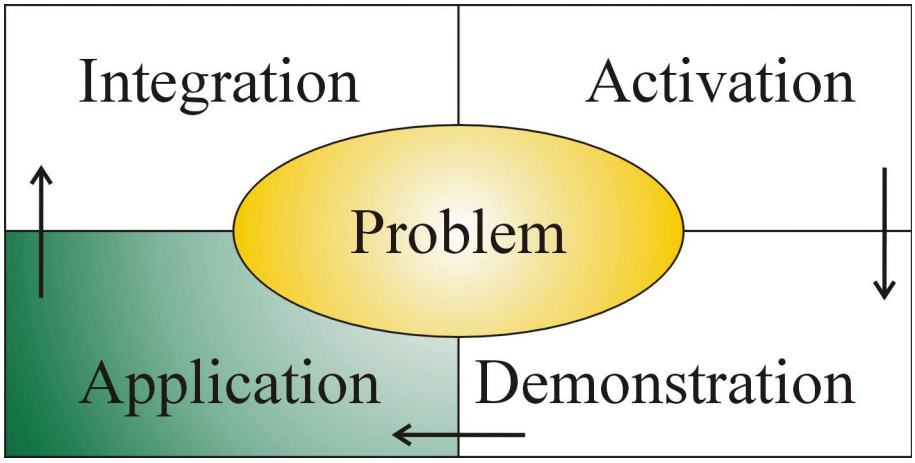
Sound has certain disadvantages, as pointed out by Fleming and Levie, "Print and pictures are more durable than speech, they are available for processing longer." (Fleming & Levie, 1978, as quoted in Gagné, 1987, p. 241.) Sound also requires additional hardware and can be very distracting, particularly if the program is to be used in a computer laboratory situation. It can, of course, be turned off or muted but then any benefit of narrated explanations is lost.

3.5 Conclusion

The lecturer, Ms Friede Wenhold, successfully organised the content of the Anthropometry course into the categories Tell, Show, Ask and Do. This enabled the design team at Telematic Learning and Education Innovation to develop a multimedia program according to Merrill's Model.

The prototype was completed in time for the planned formative evaluation. Third-year dietetic students were observed by their lecturer, the designer and the researcher while they were using the program. They then completed a questionnaire and were given an opportunity to express their views in an open discussion. The next chapter discusses the findings of that evaluation.

Chapter 4 - Application



"Learning is best when there is a series of problems to solve and when coaching is gradually withdrawn for each successive problem."

(Merrill, 2001, p.7)

Chapter 4 – Application

4.1 Introduction

This chapter provides an overview of the formative evaluation of the multimedia program for Nutritional Assessment. The aim of the evaluation was to obtain feedback from students and the course lecturer about the program and to obtain answers to the following research questions:

1. What is the role of a real-life **Problem** in a digital learning environment?
2. What is the importance of **Activation** of relevant experience or existing knowledge?
3. How successful can **Demonstration** be in a digital learning environment?
4. How significant is the **Application** of the new knowledge under guidance in a digital learning environment?
5. Is effective **Integration** of new knowledge possible in a digital environment?

4.2 Summative versus Formative Evaluation

Regardless of the design model or design process used, instructional software should be evaluated and tested before it is used in a classroom situation.

According to Lippert, the evaluation stage in the design and development process appears to be one of the most neglected facets of the instructional design and development process (as quoted in Strehler, 1994, p. 96).

4.2.1 Summative evaluation

Summative evaluation is the evaluation done at the end of the program development after all revisions are completed. It is by no means the final step in the development of a program. After the implementation of any instructional software, user feedback should be obtained and the program revised. This form of evaluation falls outside the scope of this project.

4.2.2 Formative evaluation

Formative evaluation, also called pilot testing, field testing or usability testing, is the evaluation of the program using representatives of the target population, while it is still being developed. While members of the target population use the program they are being supervised and observed by both the developer and designer, or by one of the two. The observers search for answers to questions like “What is working?, What needs to be improved? and How can it be improved?” (Worthen and Sanders, 1987, as quoted by Reigeluth, p. 636)

According to Alessi and Trollip (Alessi & Trollip, 1991, p.379) pilot testing is a seven-step process:

Step 1 - Select the helpers
Step 2 - Explain the procedure to them
Step 3 - Find out how much of the subject matter they already know
Step 4 - Observe them through the lesson
Step 5 - Interview them afterwards
Step 6 - Assess their learning
Step 7 - Revise the lesson

4.3 Quantitative versus Qualitative Research

From Alessi and Trollip's steps it is fairly clear that the formative evaluation process relies heavily on observation and on the individuals who take part. It is therefore a qualitative rather than a quantitative process. The distinction is explored by McMillan and Schumacher,

> At one level, quantitative and qualitative refer to distinctions about the nature of knowledge - how one understands the world and the ultimate purpose of research. On another level of discourse, the terms refer to research methods - how data are collected and analysed - and the type of generalisations derived from the data.
>
> (McMillan & Schumacher. 1993. p. 14)

In table 4.1 an attempt is made to place the methods used in the study into the research categories, as defined in McMillan & Schumacher (1993. p. 14).

	Category	Quantitative research	This project	Qualitative research
1.	Assumptions	Assumes that there are **facts** that can be separated from feelings and the beliefs of individuals.	Assumed that each individual student would experience the multimedia tutorial in her own way.	Assumes that there are **multiple realities** that are defined by individuals and cultures.
2.	Research Purpose	Tries to explain causes and establish relationships.	Tried to explain the responses of the students to the tutorial.	Tries to understand social phenomena.
3.	Research Methods	Has established steps and procedures.	Used more than one method of data gathering.	Offers great flexibility in methods.
4.	Typical Studies	Uses experimental or correlational designs to reduce bias and error.	Took into account the subjectivity of the target group that was observed.	Tries to control bias through design and takes into account subjectivity in data analysis and interpretation.
5.	Researcher Role	Needs a detached observer.	Made use of disciplined subjectivity.	Makes use of disciplined subjectivity.
6.	Importance	Attempts to establish universal context-free generalisations.	Developed context-bound generalisations.	Develops context-bound generalisations.

Table 4.1 - Differences between quantitative and qualitative research

The differences between quantitative and qualitative research are summarised in table 4.2 below.

Quantitative research:	**Qualitative research:**
• aims to test theories; • determines facts; • needs a representative sample; • results are statistically analysed; • demonstrates relationships between variables; • aims to fulfil predictions; • seeks to establish relationships and explain causes of changes; • uses established set of procedures; • controls for bias through design; • collects data using an instrument; • tries to establish universal context-free generalisations.	• aims to develop theories; • aims to facilitate understanding; • increases insight; • promotes better self-understanding; • aims to understand the social phenomenon from a particular perspective; • does not need a representative sample; • uses flexibility in methods and in the research process; • takes into account subjectivity in data analysis and interpretation; • data needs to be collected by skilled, prepared persons; • develops context-bound generalisations.

Table 4.2 - Quantitative research vs qualitative research

4.4 Collecting the Data

Step 1 - The helpers

The target population for the final program are the dietetics students enrolled for the Nutritional Assessment modules (NTA 311, NTA 312, NTA 321 and NTA 322). The students enrolled for the courses Nutritional Assessment courses (DTE 310 and DTE 321) in 2001 were chosen for the formative evaluation. These 25 students had completed the course, but had not yet written their final examination in the two courses. All were female, the average age was 22 years (the youngest of the group 20 years old, the oldest 30 years) and most of them were Afrikaans-speaking.

Step 2 - The procedure

It was explained to the students that their testing of the program was a formative evaluation of the program, i.e. the development of the program was not yet complete; some pages, photos and videos were still missing and there might be technical problems.

The procedure was as follows:

- The program was installed on the computers in the computer laboratory on the medical campus.
- The students had to sign a consent form to participate in the evaluation (Appendix C).
- The students were then given an hour to test the program.
- After an hour they were given a questionnaire to complete (Appendix D).
- The evaluation was concluded with a group discussion.

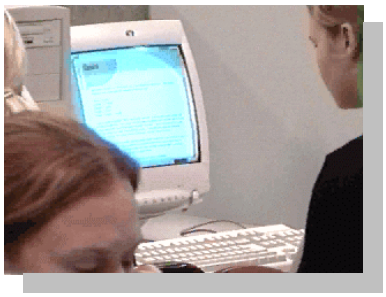


Figure 4.1 - Students in the computer lab

Step 3 - Knowledge of subject matter

Since the program was tested about two weeks before the final examination of the students, their knowledge of the subject matter was assumed to be good.

Step 4 - Observation of the students during their testing of the program

Ms Friede Wenhold (the lecturer and the subject matter expert), Ms Henriëtte Wolmarans (the designer) and Ms Helga Nordhoff (the researcher) observed the students while they were using the Anthropometry tutorial. All three observers were available to answer questions and to assist students as required. The students were requested **not** to ask for help from their fellow students so that the observers would be aware of all problems encountered.

Step 5 - Interview afterwards

The opinions of the students was gathered through a questionnaire (Appendix D) and after that they had an opportunity to share their views and express their opinions in a group discussion. The group discussion was captured on video for record-keeping purposes and to enable the observers to review the opinions expressed by the students.

Step 6 – Assessing the learning

No formal assessment of the learning was done, since it was assumed that the students knew the course material. The researcher accepts Clark's (1994) conclusion that media do not influence learning and Russel's (1999) contention that there is no significant difference between the performance of students who use different media. The students were however asked two questions about their own learning in the questionnaire.

Step 7 – Lesson revision

No lesson revision was done. The students who used the prototype had completed the course and it was assumed that they were familiar with the content of the course. Further testing was beyond the scope of this study.

4.5 Discussion of the Findings

The designer concentrated her observations on the technical problems of the program, i.e. on navigation that did not work, on places where the program failed, and on why students needed assistance. During the evaluation she mentioned that she never realised how much could be learned from just watching students use a program.

The lecturer concentrated her observations on content-related problems experienced and answered questions in this regard.

The researcher observed both the technical problems and the content-related problems, as well as the interaction between the students and between student and program.

Figure 4.2 - Students using the prototype

Although the students were requested to refrain from asking their fellow students for help, most of them checked what their neighbours were doing or tried to find out from a neighbour how to get to a certain screen. After approximately 45 minutes, the students started to get restless; they talked to their neighbours and a few quickly checked their e-mail. This was taken as an indication that they wanted to continue with the more formal part of the evaluation and the questionnaire was handed out.

The questions in the questionnaire were grouped to supply answers to the following:

- The student's impressions about the "look and feel" of the program.
- Navigation within the program.
- The student's impressions about the subject matter in the tutorial.
- The possible use of the program.
- General opinion about the program.
- The computer literacy of the students.

Questions 41 - 44 were open questions giving the student the opportunity to mention something that she liked or disliked, which might not have been addressed by any of the other questions.

The number of responses to each question is given together with the question in Appendix D.

The findings are discussed below under the **Problem** and Merrill's four phases of instruction, **Activation**, **Demonstration**, **Application** and **Integration** and under the subheadings: Observations, Questionnaire, Open questions and Group discussion. The figures that follow give graphical representations to relevant answers from the questionnaire.

For most questions the students had four choices:

'I strongly agree', 'I agree',

'I disagree' and 'I strongly disagree'.

The legend for the graphs is shown in the figure on the right.

Figure 4.3 - Legends for graphs

4.5.1 Problem

From the observations

Only a few students attempted to solve one of the two case studies in the program because most did not read the introductory screen and did not know what was expected of them.

From the questionnaire

The two case studies presented in the program were perceived as real-life problems. Nineteen of the 25 students (76%) that indicated that they would like to have more case studies in the program. Seven felt strongly about this, although only a few students actually attempted to solve one of the two case studies given.

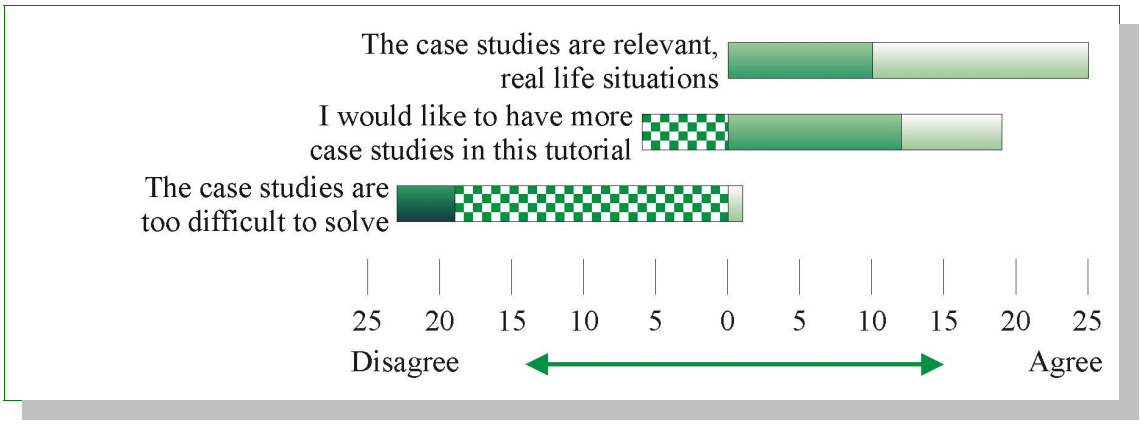


Figure 4.4 - Answers to the questions about the case studies in the program

4.5.2 Activation

The findings about the activation of pre-knowledge as well as the navigation within the program will be discussed, although navigation problems influenced the activities in all four of Merrill's phases.

From the observations

After the first five minutes it was clear that none of the students had opened the Introduction screen of the tutorial. The basic working of the program is explained in the introduction and since they could not get back to the first screen, most of them did not know what to do. It took a while before they realised what was expected of them.

From the questionnaire

First impressions and the look and feel of a program form a valuable part of the gaining of attention and activation of existing knowledge phase. Most of the students (84%-96%) liked the colour scheme and thought that the quality of the photos and videos were good (96%). Their responses are summarised in the graph below.

The prototype had no sound, since it is easy to add later and the designers were under severe time pressure to get the prototype ready for the date set for the formative evaluation.

Interestingly, nearly half (44%) of the students indicated that they would not like any background sound, but 64% expressed a preference for some verbal explanations.

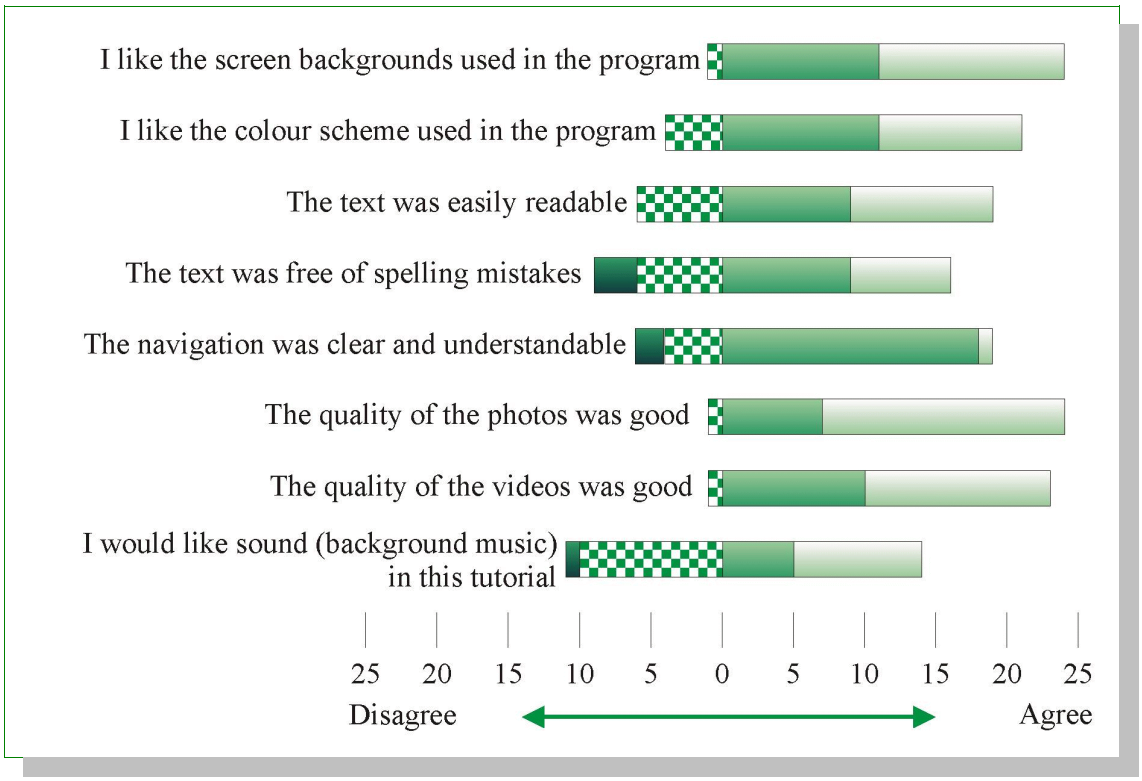


Figure 4.5 - Responses of students to questions about the look and feel of the program

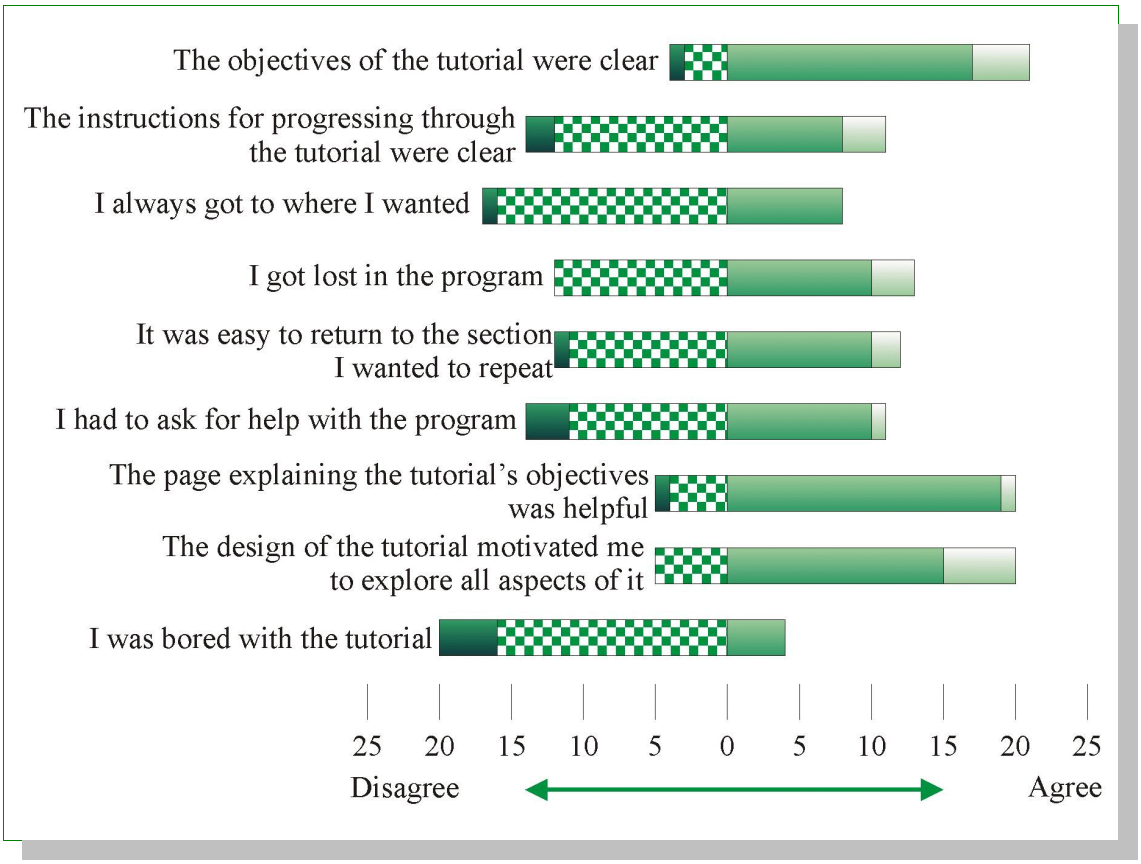


Figure 4.6 - Responses of students to questions about the navigation within the program

From the open questions

The main complaint about the program was that the navigation was not clear, that they got lost or could not go back to where they wanted to be (50%).

From the group discussion

It became clear during the group discussion that the students thought that the navigation in the program should be improved. They particularly requested a more web-like navigation as well as a search facility and a hyperlinked index.

4.5.3 Demonstration

From the observation

The students seemed fascinated by the photos and videos, which explained the different measuring and evaluation techniques and attempted to fill gaps in their own existing knowledge about the measuring techniques.

While observing the students the lecturer realised that there were mistakes in some of the photo-graphs showing measuring techniques. Some students noticed this as well and remarked that now that they had seen the incorrect procedure they understood how it should not be done.

From the questionnaire

Generally the students responded positively to questions about the content, amount and quality of information. As mentioned above, they were particularly impressed with the photos and videos which explained the different measuring techniques as well as the fact that most of the resources they needed were available in the program. Since the students had just completed the course, they were in a good position to evaluate the content as well as the amount of information presented in the tutorial.

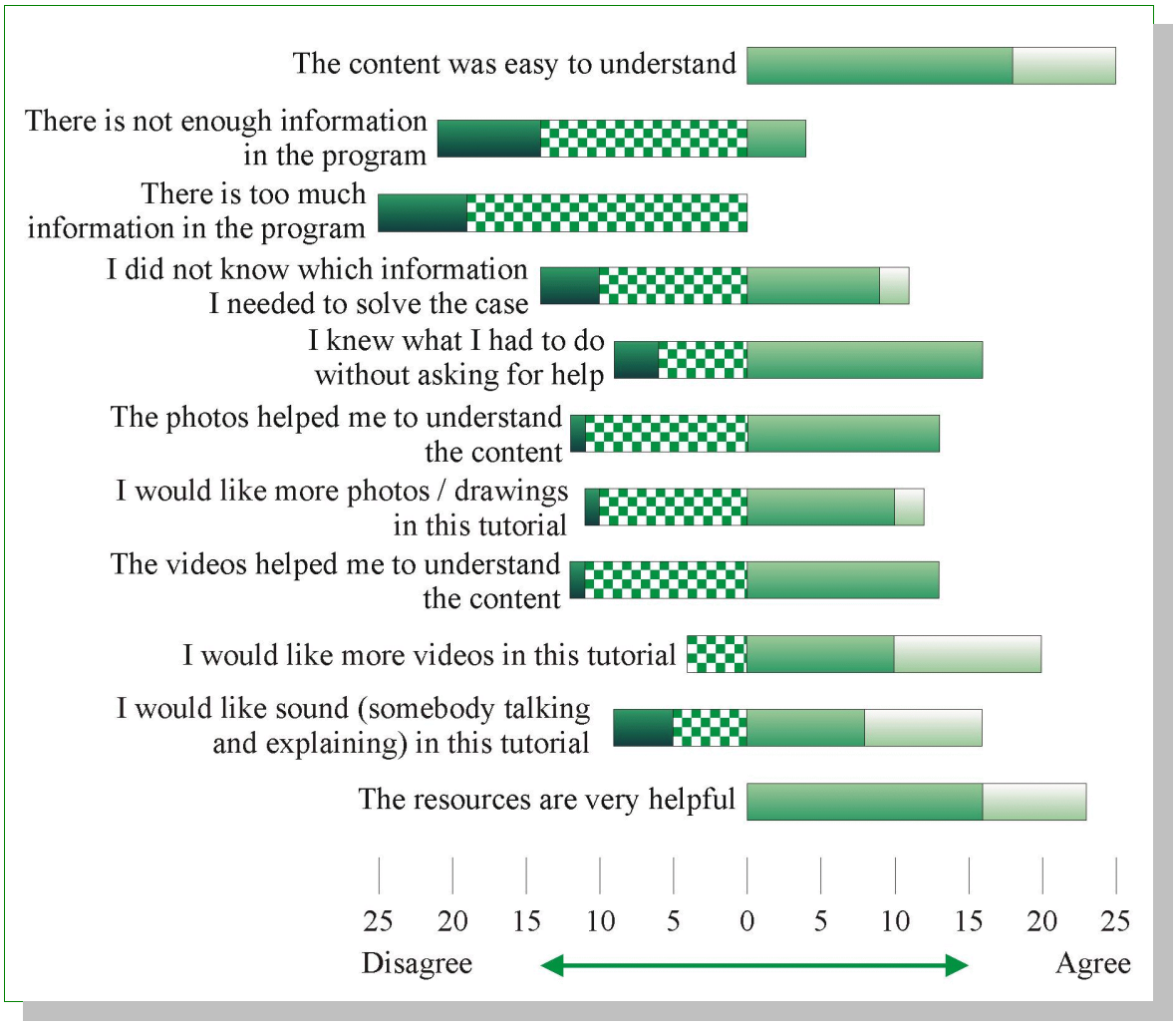


Figure 4.7 - Responses to questions about the content of the tutorial

From the open questions

Sixty percent of the student said that the photos and videos and the way the measuring and evaluating techniques were described were the best feature of the program. Six students thought that the best feature of the program was the fact that all the Anthropometry resources (such as charts, tables and graphs) were together in one place.

From the group discussion

During the groups discussion the students remarked that they wished they had had the program during their practicals to use as reference source.

4.5.4 Application

From the observation

Few students attempted to solve the case studies in the program. Their own problems were more important than the real-life case study supplied by the lecturer. One student even took out a ruler to check the procedure to measure knee-ankle length.

From the questionnaire

Encouraging for the future implementation of the program is the fact that **only one** student would not like to use the program again. This student, however, indicated that she is afraid of the computer. Three students said that they would not recommend the program to others; one of these students is afraid of computers and another one indicated that she does not like to work on the computer.

Thirteen students (52%), all with Afrikaans as home language, indicated that they would prefer to have the program in Afrikaans.

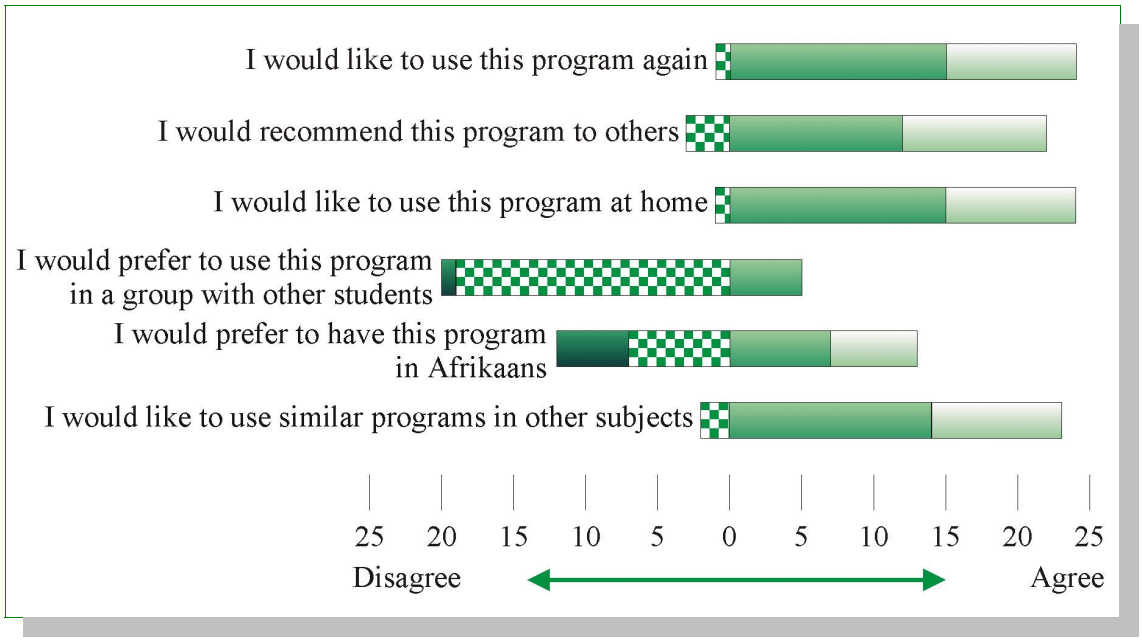


Figure 4.8 - Responses to questions about the future use of the program

From the group discussion

During the groups discussion the students remarked that they wished they had had the program when they started the course.

4.5.5 Integration

The final integration of new knowledge with existing knowledge was not planned as part of the program. This should take place in the skills lab where the students get the opportunity to practise on each other.

From the questionnaire

The fact that 64% of the students said that they learned something new from the tutorial during the 50 minutes of testing the program is a good indication that the program has value as a teaching tool. Merrill says that, "If a product does not teach, it has no value" (Merrill, 1997). The response to question 34 is even more important, where 92% of the students indicated that they thought they could apply what they had just learned in a practical situation.

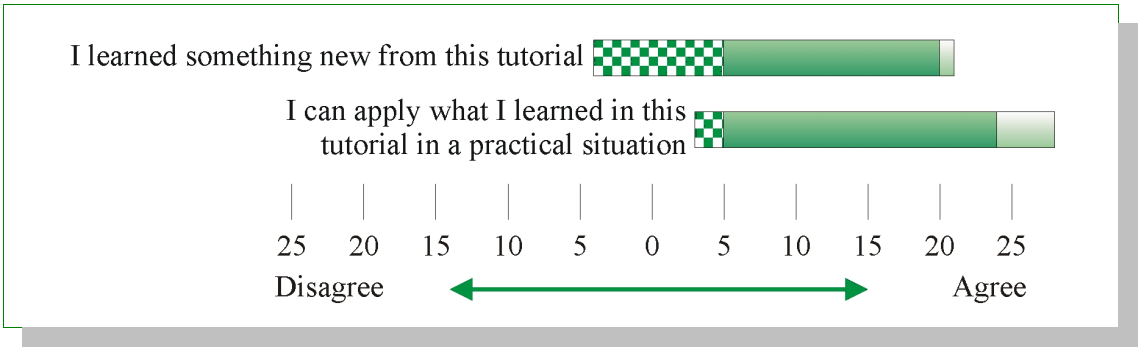


Figure 4.9 - Responses to questions about their own learning

From the open questions

Most (11) students would not like to receive computer-based instructions (CBI) **in the place of** lectures or practicals, **but as additional tuition**. Five students did, however, say that they would prefer CBI to lectures since it allows them to learn in their own time.

From the group discussion

The students expressed their disappointment that a similar program had not been available for them to use when they started the Nutritional Assessment course at the beginning of the year. There was general agreement that the computer-based course should not replace any of the existing lectures or practicals. It was suggested that the lecturer use the program during her lectures to illustrate the measuring techniques more effectively. The students also indicated that they would like to have the program at home for practice and revision.

4.5.6 Students' computer literacy and Internet access

The students considered themselves computer literate; this was supported by the fact nearly half of them (48%) use the computer daily and the most of the others (44%) at least once a week. None of them, however, thought to use the Alt-Tab keys to get to the calculator or NotePad window that had disappeared, indicating that they were not too familiar with keystroke shortcuts.

Questions 45 - 61 were asked to determine the computer literacy of the students as well as their access to and reason for using the Internet. These questions were asked to investigate a possible correlation between their ease of navigation in the program and level of computer literacy.

4.5.7 Students' language preferences

Although 15 students (60%) gave Afrikaans as their home language, less than half of them (44%) prefer to receive the instruction in Afrikaans. Twenty-eight percent prefer it in English and 20% in both languages. During the group discussion some students indicated that they had language problems when interpreting the case studies.

4.5.8. Suggestions by students

Suggestions by the students to improve the program included:

- A better overview of what is available on the CD and easily accessible menus or a clickable index (36%).
- The facility to view the case study while doing a calculation or reading values off a chart (16%).
- Improved quality of the scans or re-typed tables.
- More photos and colour, added sound, formulae explained and more words in the glossary.

4.5.9 Feedback from the Statistician

Ms Hermi Borraine, a statistician in the Department of at the University of Pretoria, analysed the data from the questionnaire and looked for possible correlations. Since the group of students was very homogeneous no correlations were expected and the few correlations that were found only confirmed that the answers to the questions were consistent.

4.6 Conclusion

The students' positive attitude towards the evaluation session was evidenced by the fact that they explored the multimedia program willingly and inquisitively. They openly discussed problems they encountered, gave valuable feedback and made positive suggestions for the improvement of the program.

Interestingly, the students liked those aspects that helped them most to learn new skills (photos and videos) or assisted them in solving the problem (all resources grouped together). What they liked least were mostly technical problems: navigation, text that was difficult to read, windows that closed or disappeared. These were perceived as obstacles preventing them from learning and acquiring new skills or solving a problem.

Encouraging for the future implementation of the program is the fact that **only one** student would not like to use the program again. This student, however, indicated that she is afraid of the computer. Three students said that they would not recommend the program to others; one of these students is afraid of computers and another one indicated that she does not like to work on the computer.

An attempt is made in the table below to apply Merrill's 'Stars' to the prototype program, taking into account the findings discussed above.

4.6.1 Applying Merrill's five Stars

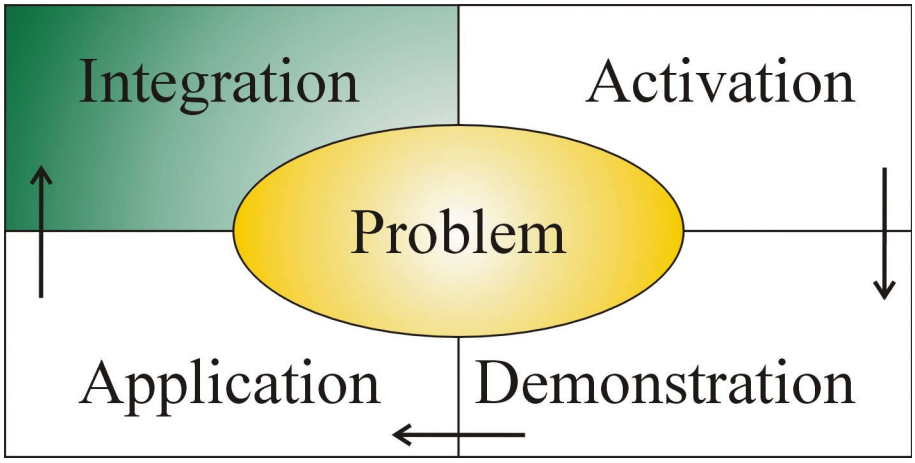
Stars (*) are a subjective, qualitative attempt at rating the success of the program.

1.	Is there **a Problem to Solve**? Yes. The case studies were seen as relevant, real-life situations.	
2.	Is there **Activation** of existing knowledge? No, but according to the lecturer there is no relevant past experience or knowledge, expected from the students for this course. The program could be improved by a screen depicting a typical situation for a dietitian to achieve what Gagné calls gaining the attention.	
3.	Is there **Demonstration**? Is the student shown and is the demonstration consistent with the learning goal? Yes. The students were particularly impressed with the photos and videos explaining the different measuring and evaluation techniques.	
4.	Is there **Application** of the new knowledge? Yes. The students had to solve the case given in the tutorial by doing the necessary calculations and writing a report in NotePad. The report would be available for evaluation by the lecturer at the end of the session or a multitude of sessions.	
5.	Is there **Integration** of the new knowledge Real integration was never planned for this program. The first integration of the new knowledge is planned for the skills lab where the students practise on each other and then ultimately in the hospital when they have to assess their first patient under the guidance of the lecturer.	

Table 4.3 - Applying Merrill's Stars

According to this, the prototype was rated at three Stars.

Chapter 5 - Integration



"Learning is facilitated when the learner can reflect on, discuss, and defend his or her new knowledge."

(Merrill, 2001, p. 7)

Chapter 5 – Integration

5.1 Introduction

This chapter synthesises the findings from the data collected during the formative evaluation of the program and focuses on answers to the research questions:

1. What is the role of a real-life **Problem** in a digital learning environment?
2. What is the importance of **Activation** of relevant experience or existing knowledge?
3. How successful can **Demonstration** be in a digital learning environment?
4. How significant is the **Application** of the new knowledge under guidance in a digital learning environment?
5. Is effective **Integration** of new knowledge possible in a digital environment?

The chapter considers the integration of the five elements of Merrill's Model and how they influence each other.

The limitations of the study are discussed briefly. Recommendations for the use of the program in the curriculum and for additional development of the program are made, as well as recommendations for further research.

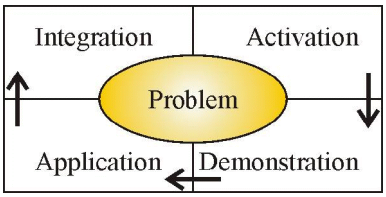
5.2 Discussion of the Conclusions

The addition of this multimedia tutorial to the Nutritional Assessment course is an attempt to provide a more flexible learning environment based on a sound instructional strategy, for the students. As noted by Merrill,

> An appropriate instructional strategy incorporates all of the necessary conditions for presenting the knowledge or demonstrating the skill, providing practice with feedback, and providing learner guidance for a given type of outcome. Information that does not include presentation, practice, and learner guidance is information but not instruction. (Merrill in Reigeluth, 1999, p. 401)

The answers to the above research questions were concluded from the questionnaire, the observation of the students during the evaluation of the program and the group discussion after the evaluation. All observers were impressed by the commitment of the students and their willingness to assess the program critically and express their views.

5.2.1 What is the role of a real-life Problem in a digital learning environment?



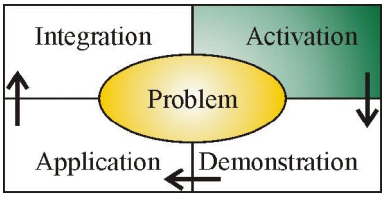
The role of a real-life problem in a digital environment is the same as its role in a normal classroom situation. As explained by Davis and Harden,

> It is explicitly used to get students themselves to identify and search for, the knowledge that they need to obtain in order to approach the problem. (Davis and Harden, 1999. p.4)

The students perceived the case studies in the multimedia program as relevant, real-life problems and requested more case studies in the program. The fact that only a few attempted to solve one of the two case studies given can be explained by the lack of direction at the beginning of the tutorial. The students then continued searching for information to fill the gaps in their own knowledge about measuring techniques.

Presenting a real-life problem in a digital environment is insufficient. Students have to be guided to the problem.

5.2.2 What is the importance of Activation of relevant experience or existing knowledge?

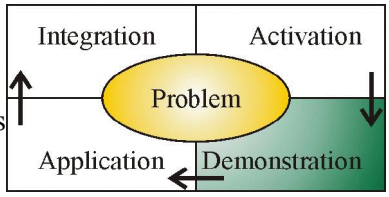


The students were generally very satisfied with the look and feel of the program as well as with the quality of the photos and videos. There was, however, a serious problem with the navigation and this prevented the activation of **relevant** pre-knowledge. Knowledge is considered to be inert and the failure to activate prior knowledge in a problem solving environment obstructs the learning process.

In a digital environment, students are often left to their own devices. If relevant pre-knowledge is not activated, the students will replace the instructional problem with their own learning problems. During the demonstration phase they will look for new knowledge to solve their own problems and during the application phase they will apply the new knowledge to solve their own problems, rather than the problem chosen by the instructor.

Students will only integrate existing knowledge with new knowledge that fits onto the foundation of knowledge called upon during the activation phase.

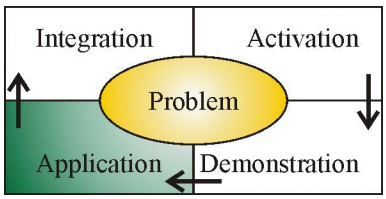
5.2.3 How successful can Demonstration be in a digital learning environment?



The photos and videos used during the demonstration phase were extremely successful to demonstrate Anthropometry measuring techniques, even to students who were supposed to know them well. The students commented that some techniques were explained better with a photo than through a real-life demonstration. The lecturer also realised that in some cases the students understood the correct technique better if the incorrect technique is illustrated as well. The erroneous technique should, however, be pointed out to the student.

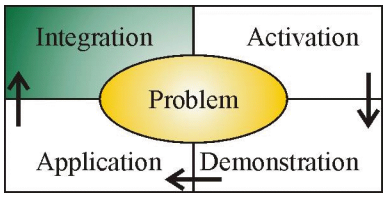
5.2.4 How significant is the Application of the new knowledge under guidance in a digital environment?

Students need to be shown how to apply the new knowledge to solve the problem. The problem-solving examples were not included in the prototype, which was one of the main complaints from the students about the program. They specifically requested examples of how to solve a case study.



5.2.5 Is effective Integration of new knowledge possible in a digital environment?

The digital environment is not the right place to practise physical skills. The final integration of new anthropometric skills should take place in the skills lab. The digital environment is, however, well suited for the writing of reports, doing calculations, tabulating data and the presentation of results from data, i.e. graphs. The students just needed more guidance in the form of examples to be able to solve a case study on the computer.



Nearly all the students saw the multimedia program as a valuable addition to lectures and practicals but not as a replacement of either.

These conclusion are summarised in tables 5.1.

	Activation	Demonstration	Application	Integration
Problem	Only relevant pre-knowledge prepares the student for the instructional problem.	Students will look for that in the new knowledge, which will solve their problem.	Students will attempt to solve their problem under guidance of lecturer.	Students will solve own problem using new skills.
Activation		The activated knowledge is foundation for new knowledge.	Combine pre-know-ledge with new knowledge to solve current problem.	Integrate new knowledge with activated knowledge.
Demonstration			Apply knowledge from demonstration to solve own problem.	Integrate know-ledge from demo with activated knowledge.
Application				Supported appli-cation is the first step towards integration.

Table 5.1 - Conclusions to research questions

5.2.6 The student's own problem

It was found that students replace the instructional problem with their own problems if the relevant pre-knowledge for the instructional event is not activated. This then has a snowball effect.

If the students' own problems have replaced the instructional problem, the students will look for solutions and applications to their problems during the demonstration phase.

In the application phase, students will again attempt to solve their own problems, rather than the instructional problem.

	Activation	Demonstration	Application	Integration
Student Problem	Wrong activation - student problem replaces the instructional problem.	Students look for solutions to own problem.	Apply new skills to own problem.	Solve own problem.

Table 5.2 - Conclusions regarding student's problem

5.3 Limitations of the Study

In the project application to Telematic Learning and Education Innovation the possibility of using the program as part of the Continuing Professional Development (CPD) program for practising dieticians and other health workers, was mentioned. The demographic profile of health workers in South Africa is totally different from the fairly homogeneous group of dietetics students. The program was not tested by members of the larger health workers group. Before it can be used as part of any Continuing Professional Development programme for health workers, it should be evaluated by a representative group.

5.4 Recommendations

5.4.1 Recommendations regarding the program

The designer received the following recommendations:

- A menu giving a good overview of the program, a clickable index, structured text using more conventional bullets and indentations, and improved navigation will make the program more user-friendly.
- If the login screen is moved to the start of the application phase (the point at which the student attempts to solve the case studies), the value of the program as a resource and reference tool may increase.
- Some activation of existing knowledge should take place. According to the lecturer there is very little knowledge that can be activated in a first-time user, but in that case, the first screen or screens should set the scene or at least gain the attention of the learner. This should help to activate relevant pre-knowledge and prevent the learners from substituting the instructional problem with their own problems.
- The planned examples of how to solve the case studies should be included to provide an opportunity for the students to practise.
- The possibility of presenting the course as an HTML-course (with CD support) should be investigated, since many resources are available and are regularly updated on the Internet.

5.4.2 Recommendations regarding the implementation of the program

Although the students were fairly computer literate, not one of them was familiar with the 'Alt-Tab' command to switch to a hidden screen. From the questionnaire it is also clear that only a few of them are familiar with spreadsheets. It is advisable to have an introductory session with the students to ensure that they have the necessary computer and Internet skills to get the optimal benefit from this program.

The program was not planned as a substitute for lectures or practicals and most students stated that they would like to use the program as an additional resource, and not as a replacement of contact time with the lecturer.

5.5. Recommendations for Further Research

The following areas offer opportunities to pursue findings from this study:

- Is there a general tendency amongst students to solve their own problems rather than the instructional problem?
- What influences the tendency amongst students to solve their own problems rather than the instructional problem?
- How does Merrill's Model work for other instructional events in the health sciences with different target populations?
- What is the value to the student of comparing correct and incorrect techniques in a digital learning environment?

5.6 Conclusion

This study investigated the implications of using Merrill's Model of Instructional Design for developing course work for senior students in the health sciences.

The formative evaluation of the prototype made it clear that the activation of relevant pre-knowledge is of utmost importance to all four instructional phases in Merrill's Model: **Activation**, **Demonstration**, **Application** and **Integration**. If the relevant pre-knowledge is not activated, the instructional problem will be replaced by the student's own problem.

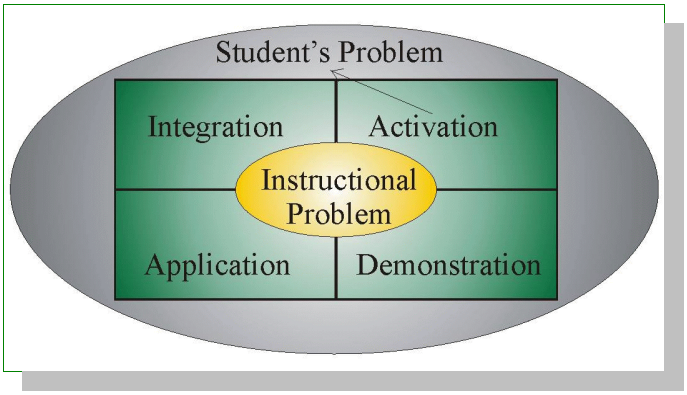


Figure 5.1 - Merrill's Model and the student's problem

It was clear from the positive responses of the students and the lecturer that the program will be a valuable addition to lectures, practicals, the textbook and other resources used in the Nutritional Assessment course. Future dietetic students as well as health workers should benefit from it, particularly if the other three sections, Biochemistry, Clinical Assessment and Dietary Assessment, are added.

This program has the potential to become a valuable, constant reference source for the practising dietician and a tool to assist other health workers in acquiring a basic understanding of Nutritional Assessment.

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“Knowledge is of two kinds: we know a subject ourselves, or we know where we can find information upon it.”

(Johnson, Samuel. 1775)

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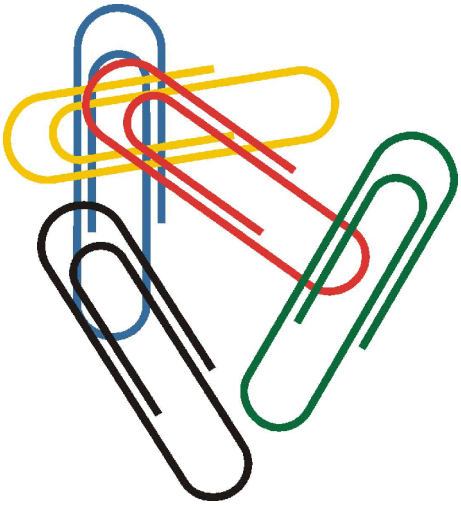
Appendixes



List of Appendices

Universiteit van Pretoria

Fakulteit Gesondheidswetenskappe
Afdeling Mensvoeding

Aansoek om befondsing van ’n navorsingsprojek vir 'n Rekenaargesteunde Onderrig (RGO) Program vir Dieetkunde

1. Projekbesonderhede

1.1 Titel ***Voedingstatusevaluering: ’n RGO Program vir Dieetkunde***

Titel (in Engels) ***“Nutritional assessment: A CAI Program for Dietetics”***

1.2 Beskrywing van projek

Die navorsingsprojek is gemik op die herontwerp van dele van vier modules in die vak “Voedingstatusevaluering” in die pas aanvaarde nuwe kurrikulum vir B Dieetkunde, naamlik: NTA 311, NTA 312, NTA 321 en NTA 322.
Daar word voorsien dat dié modules in toekoms ook in multi-professionele voor- en nagraadse opleiding van ander gesondheid(sorg)-werkers (bv. geneeshere en die aanvullende gesondheidssorg-professies), asook vir die verpligte voortgesette professionele opleiding ("*CPD - Continuing Professional Development*") van afgestudeerde dieetkundiges gebruik kan word.

1.3 Departement betrokke

Afdeling Mensvoeding (Fakulteit Gesondheidswetenskappe)

1.4 Projekleiding

Die navorsingsprojek vorm deel van die MEd (RGO) mini-skripsie van Helga Nordhoff binne die Departement Didaktiek, met Prof. Johannes Cronjé (Departement Inligtingwetenskappe, x 3884 / jcronje@up.ac.za) as studieleier.

2. Motivering vir projek

Die twee huidige vakke DTE310 en DTE 321 (toekomstige modules NTA 311, NTA 312, NTA 321 en NTA 322) word tans d.m.v. drie lesings per week en een praktikum van twee uur aangebied. Daar word nie beplan om dié onderwysmodus te verander nie, maar om dele van die vakinhoud as webgebaseerde tutoriale aan te bied.
In die Fakulteit Gesondheidswetenskappe word deurgaans ’n probleemgebaseerde onderrigbenadering gevolg. Aan studente in dieetkunde word ge-

woonlik gevalstudies voorgelê waaruit hulle dan (in bogenoemde vakke) die nodige informasie moet haal om met behulp van verwysingsmateriaal tot 'n voedingdiagnose te kom.
Die gevalstudies is normaalweg 'n geskrewe oorsig van die gesondheids-geskiedenis van die pasiënt. Met behulp van die rekenaar kan hierdie geval-studies in 'n multimedia formaat aangebied word, wat veel eerder 'n lewens-getroue situasie sou kon uitbeeld. Die student word dan die geleentheid gebied om visuele en dalk ook ouditiewe seine te moet interpreteer.
Die verwysingsmateriaal wat die studente normaalweg benodig is versprei oor 'n verskeidenheid bronne, waaronder vakhandboeke, naslaanwerke, joernale, ens. wat voortdurend wêreldwyd opdateer word. Daar word beoog om hierdie materiaal so vêr as moontlik in elektroniese formaat aan die studente beskikbaar te stel, wat die leergeleentheid kan optimaliseer.

3. Beoogde leweringsisteem

Die beoogde leweringsisteem is multimedia gevalstudies binne 'n probleem-gebaseerde onderrigbenadering deur middel van die rekenaar en die Internet.

Vir "CPD" sou die onderwysmodus verander na web-gebaseerd met CD-ondersteuning en moontlike kontakgeleenthede van een tot twee dae elk aan die begin en aan die einde van elke module. Die eerste kontakgeleent-heid kan moontlik beplan word vir ander (geskikte) leersentra. Die finale kontakgeleentheid sou beplan kon word vir die "Vaardigheidslaboratorium" (VALAB) op die mediese kampus. Gehaltemonitering sou op hierdie wyse verseker kon word.

4. Lewensvatbaarheid

4.1 Teikenmark

Die projek word gemik op ingeskrewe voorgraadse studente in Dieet-kunde. Dit kan egter in die toekoms gebruik word vir die opleiding van gesondheids(sorg)werkers asook vir "CPD" van dieetkundiges.

Voedingstatusevaluering verteenwoordig volgens die Beroepsraad vir Dieetkunde 'n kernbevoegdheid vir dieetkundiges en dit word geken-merk deur voortdurend ontwikkeling en verandering. Benewens die sowat 30-35 voorgraadse studente in dieetkunde wat jaarliks die modules deurloop, sal afgestudeerde dieetkundiges baat kan vind by die program, met verwysing na volgehoue professionele ontwikkeling. Die Afdeling Mensvoeding wil egter die modules eers op voltyds ingeskrewe studente toets voordat dit vir die opleiding van gesond-heids(sorg)werkers asook vir "CPD" van dieetkundiges ge-implemen-teer word.

5. Datum van implementering

Die program sal in die tweede semester 2001 getoets word.

6. Begroting

Hierdie begroting weerspieël die addisionele bedryfsuitgawes, gebaseer op jaarlikse onderrigaktiwiteite vir Afdeling Mensvoeding, bo-en-behalwe die normale.

6.1 Uitgawes

Begrotingsitem	2000	2001
Bedryfsbegroting		
Skryfbehoeftes, CD's, diskettes, ens.	R 400	R 500
Internet	R 1,000	R 1,500
Opleiding - Web-CT,	R 0	
Sagteware: "Dreamweaver" & "CourseBuilder", ...	R 3,500	
Drukwerk/duplisering	R 500	R 300
Aankoop van bestaande programme	R 2,000	R 500
Kopiereg vir verwysingsmateriaal, fotos, grafika ens.	R 2,000	R 500
Diverse	R 500	R 500
Totaal:	**R 9,900**	**R 3,800**
Groottotaal:		**R 13,700**

6.2 Inkomste (addisionele inkomste)

Geen addisionele inkomste word verwag nie. Addisionele inkomste sal gegenereer word as die program vir die opleiding van gesondheids(sorg)werkers, asook vir "CPD" van dieetkundiges gebruik gaan word.

7. Projekskedulering

Die volgende makroskedulering, met teikendatums vir voltooiing van take, word voorgestel met die oog op die beplanning en voorbereiding vir die program:

Voorlegging van befondsingsaansoek	16 September 2000
Besluit deur Stuurkomitee	27 September 2000?
Samestelling van projekspan	30 September 2000?
Ontwerp van leeromgewing (makro instruksionele ontwerp)	30 Januarie 2001

Ontwerp van studiemateriaal (mikro instruksionele ontwerp)	28 Feburarie 2001
Ontwikkeling van studiemateriaal	31 Maart 2001

8. Ondersteuning en opleiding benodig

Die Afdeling Mensvoeding beskik oor genoegsame mensekrag om die eerste fase van die navorsingsprojek ten opsigte van die vakinhoudelike te begelei (F Wenhold). Die rekenaarkundigheid sal deur H Nordhoff as deel van MEd (RGO) voorsien word. Daar word voorsien dat die kundigheid van 'n eksterne vakkundige benodig gaan word in die samestelling en ontwikkeling van die volledige projek. Hiervoor sal aansoek gedoen word as dit blyk dat die eerste fase van die projek suksesvol is.

Onderwyskundige ondersteuning word as 'n prioriteit beskou met die oog op doeltreffende leeromgewingontwerp en studiemateriaalontwikkeling. In hierdie verband word die ondersteuning wat Telematiese Onderwys kan lewer hoog op prys gestel.

Opleiding van personeel in die Afdeling Mensvoeding ten opsigte van telematiese onderwys en veral in die gebruik van projekbestuursagteware word voorsien.

9. Kundigheid en ervaring met telematiese onderwys

Die projekleier het ervaring met die ontwikkeling van telematiese programme, maar vir die personeel van die Afdeling Mensvoeding sal dit 'n eerste kennismaking met hierdie aanbiedingswyse wees.

10. Samewerkingsooreenkomste

Soos alreeds in 1.2 genoem word daar voorsien dat van die modules in toekoms in multi-professionele voor- en nagraadse opleiding van ander gesondheids(sorg)werkers (bv. geneeshere en die aanvullende gesondheidssorgprofessies), asook die verpligte voortgesette opleiding("CPD") van afgestudeerde dieetkundiges gebruik kan word.

Aansoek saamgestel deur Helga Nordhoff (hnordhoff@postino.up.ac.za) en Friede Wenhold (fwenhold@postillion.up.ac.za) op 16 September 2000.

_____	_____
Hoof: Afdeling Mensvoeding G.J. Gericke	Dekaan: Fakulteit Geneeskunde Prof. D. du Plessis

COURSE CONTENT OUTLINE AND REFERENCES

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
1.Anthropometry	1.1Whole Body	1.1.1Infants & Children	Weight for age		Growth monitoring Value and use of growth monitoring (1:229 – 230) What is Weight for age, and Why is it important (2:368 – 369) Indices: * Percentiles: Meaning of concept, interpretation * Percent of median: What it is used for (5:7) * Z-score (5:7-8): calculation Additional source: Bender: (http:www.odc.com/anthro/deskref/desktoc.html) Indicators: Interpretation of: * Percentiles * % of reference value * Z-score (cut-off's)	Show apparatus: *Drawings/photos* Scales: * Electronic baby scale (SECA 734: brochure) * Baby scale with sliding weights (=Paediatric beam balance scale) (SECA 725: brochure; King and Burgess p184; Lee & Nieman p229); DoH p16 * Spring scales: -Standing (=Pan scale): (DoH p17) -Hanging (King & Burgess p183; DoH p18) - Dial for spring scales (DoH p17) -Direct recording (= TALC scale (Jeliffe & Jeliffe; or own photo) Height/length meters: * Measuring rod (SECA 207: brochure) * Measuring mat (SECA 210: brochure) * Lee & Nieman p 226; 227 * Horizontal measuring board for recumbent length (DoH p 25) Demonstrate measurement techniques: *Slides/video* Weight (- Dial for spring scales (DoH p17) Height [supine and standing]; (DoH p26) Frankfort plane (Lee & Nieman p225 ; 227; DoH p30) TALC: DoH p66 + p70 Text: Jeliffe & Jeliffe; King and Burgess p177; Lee & Nieman; Whitney & Cataldo E-12) Show: * WHO Road to Health * CDC (http:www.cdc.gov/growthcharts) * SA Dept Health growth charts (DoH p35) * "Mastercard" (Jeliffe & Jeliffe; King & Burgess; DoH p38) Demonstrate: How to plot (Vertical axis: DoH p36; Horizontal axis DoH p37; Plotting weight according to birth day and month DoH p39; Plotting a child's weight according to successive months: DoH p40), record and interpret (King & Burgess p177, 183) Types of growth curves/slopes (Jeliffe & Jeliffe fig 2.15 and fig 2.7) Healthy growth: (DoH p53) Fast rising (DoH p54) Slow growth (DoH p55) Flat growth (DoH p56) Losing weight (DoH p57) Fast weight gain (DoH p58) Composite growth (DoH p59 + p60) CD Rom: Welcome Trust	Guided calculations/ Interpretation of indices Sources: Bender: (http:www.odc.com/anthro/deskref/desktoc.html) King & Burgess p192-4.	Case study Fill in growth chart Identify and interpret (segments of) growth curve Calculate and interpret indices CD Rom: Haschke F, Van't Hof, Eurogrowth Study Group: CD Program for monitoring the growth of children

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
					<u>Wellcome classification:</u> Harvard standard (% of median weight for age) Oedema Kwashiorkor Marasmus Undernutrition Marasmic kwashiorkor	Slides Oedema: McLaren p19 Moon face: McLaren p22 Marasmus: McLaren p 13; 15; Kwashiorkor: Mclaren p 19 Marasmic kwashiorkor: Mclaren p21 Wellcome Trust CD King & Burgess p222/3 Burgess 1994: 208		
					<u>Gomez weight for age classification</u> (Bender; Waterlow)			
			Waterlow classification		<u>Wasting</u> Weight for height Indices and indicators * Percentiles * % of median * Z-score Cut-off's	Refer back to weight and height Difference between wasting and stunting: (Photo: McLaren p11); Drawing: Waterlow p189 (fig 13.1) Nabarro wall chart = "Thinness chart" (Jeliffe & Jeliffe p19; King & Burgess p188) CDC growth charts (http:www.cdc.gov/growthcharts)	Guided calculations Guided interpretation of limited given data	Paper case study: On own
					<u>Stunting</u> Height for age Indices and indicators * Percentiles * % of median * Z-score Cut-off's	<u>Demonstrate:</u> How to plot on growth charts How to interpret data Wellcome Trust CD	Guided calculations Guided interpretation of limited given data	Paper case study: On own
			BMI for age		Interpretation guidelines * Percentiles * % of median * Z-score	<u>Show:</u> Apparatus <u>Demonstrate:</u> Measurement technique Formula: Calculation of BMI Show: CDC chart (=reference data)		EuroGrowth CD

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
			Upper arm circumference		Chart: King & Burgess p189 Indices and indicators MUAC cutpoints for field work MUAC for age tables (=reference data: gender and non-gender-specific) Interpretation: * Percentiles * % of median * Z score	Show: Apparatus *Pictures: Bands/tapes* * Tape measure Jeliffe & Jeliffe: fig 2-4; 2-5 * Insertion (TALC) tape: (King & Burgess p191: ; DoH p 32; Burgess, 1994:255) * Shakir strip: King & Burgess p190 * "Finger and thumb" King & Burgess p195 Werner & Bower 25-15/6*; Burgess, 1994:255* Demonstrate: Measurement technique (Bender; King and Burgess p190-1; DoH p31) MUAC for age tables (de Onis; King & Burgess 1995:189)	"Paper case" Guided interpretation using different indices	Taking measurement in real life "Calibrating" own finger and thumb Devising own strip Group work: Survey + experiment: Assess children in a hospital ward/creche with tape and finger/thumb. Compare results; Calculate correlation coefficient between results from the two methods Determine prevalence of malnutrition

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
		1.1.2Adults	Weight - Height tables		Advantages/limitations of WHT How to determine frame size using * Elbow breadth * Wrist circumference	Show apparatus : *Drawings/photos* Scales: * Flat bathroom scales Mechanical seca 762 Electronic seca 882/770/881 * Column scales Mechanical = Balance beam (seca 710/712; Lee & Nieman p229; DoH p20) Electronic (seca 705) Zero-balancing of and reading arms of platform beam balance scale: DoH p21) * Chair scales Mechanical (seca 941) Electronic (seca 940/921) *Bed scales seca 784 Lee & Nieman p 229 Height meters: * Electronic stadiometer with cableless data transmission (seca 245) * Telescopic measuring rod (seca 222/1 * Tape measure for wall mounting Calipers: * Sliding (Lee & Nieman p240) * Spreading (Photo) Demonstrate: Measurement techniques Weight Height (DoH p28) Frankfurt plane (DoH p29) Elbow breadth Wrist circumference Show: WHT (Metropolitan '59, '83; Age specific) Lee & Nieman p 234; 235; 237	Guided case study: Weight evaluation	Independent case study: weight evaluation Perform measurement and evaluation of weight (fellow student VALAB) or hospital patient

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
			Relative weight		Interpretation Lee & Nieman p241;	Formula for calculation Lee & Nieman p241	Guided case study: Calculate and interpret given data	
			BMI		Cutpoints Cormic Index	Formula for calculation Table/Calculator (Web) <u>Demonstrate:</u> Measurement of sitting height Formula/ Interpretation	Guided case study: Perform calculations and interpretation	
	1.2Body composition	1.2.1Fat component	Fat distribution		Waist circumference Cutpoints Sex-specific Age-specific	<u>Demonstrate:</u> Measurement: Waist	Guided case study Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)
					Waist hip ratio Cutpoints	<u>Demonstrate:</u> Measurement Waist Hip		
			Single skin folds		Triceps Interpretation: Indices * Percentile * % median * Z-score	<u>Show:</u> Apparatus *Photos/diagrams* * Harpenden caliper * Holtain caliper * Lange caliper * Slimguide <u>Demonstrate:</u> Measurement principle (slides: Bosch/Loedolff; Lee & Nieman p250) <u>Demonstrate:</u> Site selection (Bosch Loedolff; Lee & Nieman p254) <u>Show:</u> Percentile charts (Lee & Nieman Appendix O p 633-6)	Guided case study: Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
					Subscapular Interpretation: Indices * Percentile * % median * Z-score	Show: Apparatus *Photos/diagrams* * Harpenden caliper * Holtain caliper * Lange caliper * Slimguide Demonstrate: Measurement principle (slides: Bosch/Loedolff; Lee & Nieman p250) Demonstrate: Site selection (Bosch Loedolff; Lee & Nieman p255) Show percentiles: Lee & Nieman Appendix P p638-640)	Guided case study: Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)
			Combination of skinfolds		TSF + SSF Interpretation: Indices * Percentile * % median * Z-score + Classification	Show: Apparatus *Photos/diagrams* * Harpenden caliper * Holtain caliper * Lange caliper * Slimguide Demonstrate: Measurement principle (slides: Bosch/Loedolff; Lee & Nieman p250) Demonstrate: Site selection (Bosch Loedolff; Lee & Nieman p255) Show percentiles: Lee & Nieman Appendix Q p641-3)	Guided case study: Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
			Total body fat		Combinations of folds Converting body density to %BF (Lee& Nieman p260) Interpretation = classification of % body fat (Lee& Nieman p264) Calculation of total fat weight	Site selection (Bosch & Loedolff): Biceps Chest (Lee & Nieman p254) Midaxillar (Lee & Nieman p255) Supra-illial (Lee& Nieman p 256) Abdominal (Lee & Nieman p257) Thigh (Lee & Nieman p257-8) Calf (Lee& Nieman p258) Formulae: Calculations Lee& Nieman p261 Nomogram Lee& Nieman p262 Classification of %BF Formula to calculate total fat weight (Lee & Nieman p264	Guided case study: Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)
			Arm fat area (AFA)		Interpretation Mahan p373; Appendix 29)	Formula (Mahan p373) How to calculate How to use nomogram Percentiles (Appendix 29 of Mahan) <u>Show:</u> Apparatus for taking TSF *Photos/diagrams* * Harpenden caliper * Holtain caliper * Lange caliper * Slimguide <u>Demonstrate:</u> Measurement principle TSF (slides: Bosch/Loedolff; Lee & Nieman p250) <u>Demonstrate:</u> Site selection TSF (Bosch Loedolff; Lee & Nieman p254) Site selection MUAC (How to take MUAC	Guided case study: Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)
		1.2.2Fat free component	Arm muscle area (AMA)		Interpretation of (c)AMA Lee& Nieman	Formula AMA (Lee & Nieman p304) Formula cAMA (Lee& Nieman p304) Nomogram (Lee& Nieman p305) Percentiles (Appendix R Lee & Nieman p644-6) Interpretation guidelines of AMA (Lee & Nieman p306 Table 7-6)	Guided case study: Perform calculations Interpret	Independent case study Perform measurements and interpret on fellow students (VALAB) or in real life (hospital patients)

Nutritional assessment - Anthropometry and body composition				Obj	Tell	Show	Ask	Do
			Total fat free weight			Formula to calculate fat free weight (refer to total body fat)		
2.Electrical conductance	BIA				Theoretical/underlying principle	Show apparatus Pictures form manufacturers Diagrams Demonstrate Placement of electrodes		
3.Densitometry	Underwater weighing				Theoretical principles	Formula	Formulae & calculations Density %Body fat Classification	Case study
4.Other methods for assessing body composition					Computed tomography Magnetic resonance imaging DEXA	Show: Images		

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7. Jelliffe, B D & Jelliffe, E F (1990): Growth monitoring and promotion in young children: Guidelines for the selection of methods and training techniques. Oxford University Press. New York.

DoH = Department of Health

King & Burgess = King FS & Burgess A. Nutrition for developing countries2nd ed. Oxford University Press 1995.

Consent form to participate in the evaluation of a Multimedia Program for Anthropometry

1. Research study

I, _____ willingly agree to participate in the evaluation of a multimedia computer program. The evaluation is part of the research done for a MEd (CIE) in the Faculty of Education, University of Pretoria by Helga Nordhoff.

2. Purpose of Evaluation

A computer-based program on Nutritional Assessment to be used by future dietetics students is being developed by Telematic Learning and Education Innovation at the University of Pretoria. The first phase of the development is nearing completion and the evaluation of the program at this stage is important to ensure a user-friendly final program.

3. Description of Procedures

The computer program has been installed on the computers in the computer lab. You are requested to test the program for approximately one hour. Critically look at it as another resource from which you could learn more about Anthropometry. Read the instructions, follow the links, check the resources, etc.
If you need assistance, request help from Ms. Friede Wenhold (your lecturer), Ms. Henriette Wolmarans (the designer) or Ms. Helga Nordhoff (the researcher). Please do not consult your fellow students, since your own opinion is needed in this evaluation.
After an hour, you will be given a questionnaire to complete. Please answer all questions honestly. The evaluation will end with a short group discussion. The group discussion will be captured on video, for record purposes only.

4. Voluntary participation

Participation in this evaluation is voluntary.

5. Confidentiality

All information provided by you during this evaluation will be kept confidential.
No information by which you can be identified will be released or published.

I have read all of the above, had time to ask questions, received answers concerning areas I did not understand and I willingly give my consent to participate in this evaluation.
Upon signing this form, I will receive a copy.

Name: _____

Signature: _____ Date: _____

Witness 1: _____ Date: _____

Witness 2: _____ Date: _____

Toestemmingsvorm vir die Deelname aan die Evaluasie van ’n Multimedia Program vir Anthropometrie

1. Navorsingstudie

Ek, _____ stem hiermee gewillig in tot die deelname aan die evaluasie van ’n multimedia-rekenaarprogram. Die evaluasie is deel van die navorsing wat vir ’n MEd (CIE) in die Fakulteit Opvoedkunde, Universiteit van Pretoria, deur Helga Nordhoff gedoen word.

2. Doel van die Evaluasie

’n Rekenaarprogram oor Voedingstatus-evaluering vir toekomstige dieëtkundestudente word tans deur die Departement Telematiese Leer en Onderwysinnovasie aan die Universiteit van Pretoria ontwikkel. Die eerste fase van die ontwikkeling nader voltoïng en die evaluasie van die program op hierdie stadium is belangrik om te verseker dat die finale produk ’n gebruikersvriendelike program sal wees.

3. Beskrywing van die Prosedures

Die rekenaarprogram is alreeds op die rekenaars in die rekenaarlaboratorium ge-installeer. U word versoek om die program vir omtrent ’n uur te toets. Kyk krities na die program as ’n additionele bron waar u meer oor Anthropometrie kan leer. Lees die instruksies, volg die skakels (links), kyk na hulpmiddele, ens.
Indien u iets nie verstaan nie, versoek Me. Friede Wenhold (u dosent), Me. Henriette Wolmarans (die ontwerper) of Me. Helga Nordhoff (die navorser) om u te help. Moet asseblief nie u mede-studente raadpleeg nie, aangesien ons u eie opinie oor die program wil inwin.
Na een uur sal u ’n vraelys kry om te antwoord. Antwoord asseblief alle vrae eerlik. Die evaluasie sal met ’n kort groepsbespreking afgesluit word. Die bespreking sal vir rekorddoeleindes op videoband vasgelê word.

4. Vrywillige Deelname

Deelname aan hierdie evaluasie is vrywillig.

5. Vertroulikheid

Alle inligting deur u tydens die evaluasie verskaf sal vertroulik gehou word. Geen inligting waardeur u geïdentifiseer kan word, sal gepubliseer word nie.

Ek verklaar hiermee dat ek hierdie dokument gelees het, tyd gegun is om vrae te stel, antwoorde op my vrae rakende onduidelike aspekte oor hierde evaluasie ontvang het en vrywillig toestemming gee om deel te neem aan hierdie evaluasie.
By weë van ondertekening van hierdie vorm, sal ek ’n kopie ontvang.

Naam: _____

Handtekening: _____ Datum: _____

Getuie 1: _____ Datum: _____

Getuie 2: _____ Datum: _____

Questionnaire for the Evaluation of a Multimedia Program for Anthropometry

	My impressions of the "look & feel" of the program	Strongly Agree	Agree	Disagree	Strongly Disagree
1.	I like the screen backgrounds used in the program	13	11	1	
2.	I like the colour scheme used in the program	10	11	4	
3.	The text was easily readable	10	9	6	
4.	The text was free of spelling mistakes	7	9	6	3
5.	The navigation was clear and understandable	1	18	4	2
6.	The quality of the photos was good	17	7	1	
7.	I would like more photos / drawings in this tutorial	4	10	10	1
8.	The quality of the videos was good	13	10	1	
9.	I would like more videos in this tutorial	10	10	4	
10.	I would like sound (background music) in this tutorial	9	5	10	1
11.	I would like sound (somebody talking and explaining) in this tutorial	8	8	5	4

	Finding my way around the tutorial	Strongly Agree	Agree	Disagree	Strongly Disagree
12.	The objectives of the tutorial were clear	4	17	3	1
13.	The instructions for progressing through the tutorial were clear	3	8	12	2
14.	I always got to where I wanted to go		8	16	1
15.	I got lost in the program	3	10	12	
16.	It was easy to return to the section I wanted to repeat	2	11	11	1
17.	I had to ask for help with the program	1	10	11	3
18.	The page explaining the tutorial's objectives was helpful	1	19	4	1
19.	The design of the tutorial motivated me to explore all aspects of it	5	15	5	
20.	I was bored with the tutorial		4	16	4

	My impressions of the subject matter in the tutorial	Strongly Agree	Agree	Disagree	Strongly Disagree
21.	The content was easy to understand	7	18		
22.	The case studies are relevant, real life situations	15	10		
23.	I would like to have more case studies in this tutorial	7	12	6	
24.	The problems (case studies) are too difficult to solve	1		19	4
25.	There is not enough information in the program		4	14	7
26.	There is too much information in the program			19	6
27.	I did not know which information I needed to solve the case	2	9	10	4
28.	I knew what I had to do without asking for help		16	6	3
29.	The photos helped me to understand the content	13	11	1	
30.	The videos helped me to understand the content	13	11	1	
31.	The resources are very helpful	7	16		
32.	Enough and the most important terms are explained in the glossary	6	14	3	2
33.	I learned something new from this tutorial	1	15	9	
34.	I can apply what I learned in this tutorial in a practical situation	4	19	2	

How and where I would like to use this program		Strongly Agree	Agree	Disagree	Strongly Disagree
35.	I would like to use this program again	9	15	1	
36.	I would recommend this program to others	10	12	3	
37.	I would like to use this program at home in my own time (if you have a computer at home)	9	15	1	
38.	I would prefer to use this program in a group with other students		5	19	1
39.	I would prefer to have this program in Afrikaans	6	7	7	5
40.	I would like to use similar programs in other subjects	9	14	2	

Overview of my opinion about this program	
41.	What I liked ***most*** about this program:
42.	What I liked ***least*** about this program:
43.	How I would ***improve*** this program:
44.	I would prefer to receive more computer-based instructions in place of lectures / practicals (explain your answer).

My access to computers		Yes	No
45.	I am computer literate	21	3
46.	I have a computer at home / at my residence	22	2
47.	I like to work on the computer	17	6
48.	I am afraid of the computer	3	21
49.	I have Internet access	19	5
50.	I am familiar with instructional software (tutorials, simulations, etc.)	15	9

My use of computers		daily	at least once a week	occasionally (a few times a year)	never
51.	I use the computer	12	11	1	
52.	I use a word processor (ie. MS Word, WordPerfect)	11	11	2	
53.	I use spreadsheets (MS Excel, QuatroPro)	4	4	11	5
54.	I use a graphics program (state which one)	1	1	6	14
55.	I play games on the computer - name your favourite game(s)	3	3	5	13

My internet access		home	University	Internet café	other (specify)
56.	My Internet access is at	17	3		1

I use the Internet to:		Yes	No
57.	send and receive e-mail	19	6
58.	read newsletters from newsgroups and talk in chat groups	4	15
59.	look for information / do research	20	2
60.	download files, i.e. MP3's, software, pictures	10	10
61.	other (please specify)	1	3

Personal information					
62.	Name (optional):				
63.	Age:				
64.	Home language	Afr. 15	Eng. 6	Afr. / Eng 1	other (specify) 1
65.	Which language do you prefer to receive your instruction in?	Afr 11	Eng 7	Afr. / Eng 5	other (specify)

Other comments I would like to make: