THE EVALUATION OF AN INTERACTIVE MULTIMEDIA LEARNING RESOURCE BASED ON LEARNING STYLES OF FIRST YEAR OCCUPATIONAL THERAPY STUDENTS

DISSERTATION FOR A MASTER OF OCCUPATIONAL THERAPY DEGREE

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DEDICATION

Without the constant encouragement and meticulous feedback from my co-study leader Mrs M Aronstam this dissertation would not have been possible. Her professional calm guidance ensured that I could continue with the knowledge that every revision added value to the end product.

A big thank you is also due to my statistician dr. Steve Olorunju from the National Health Research Council for all his patience, time and knowledge that he imparted.

My husband's patience was sorely tested at times but his faith in my ability to complete this study was constant. To the rest of my family that had to put up with being neglected at times I can only say thank you for your support.

ABSTRACT

The first year occupational therapy students at the University of Pretoria participated in this study to determine the impact of an interactive multimedia CD 'Basic Biomechanics for therapists' on learning measured as achievement. E-learning was employed in an effort to remain at the cutting-edge of tertiary education for the y-generation student.

Analysis confirmed a significant improvement of t=0.00 with a table value of t>0.05 in the achievement of the participants over four tests. A survey was conducted to determine the experience of the participants. Results indicated that the use of the CD was experienced positively.

The learning style profile of the target group was determined to identify possible relationship between the learning style proponents and change in achievement. A relationship between the learning style proponents and the change in achievement was identified.

There are still unanswered questions that may be answered by further research to add to the findings of this study.

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ABBREVIATIONS AND ACRONYMS

CBT – Computer based test

CD – Compact disk

E-learning – Electronically based learning

HPCSA- Health Professions Council of South Africa

ILS – Felder - Soloman Index of Learning Styles test

LSI – Kolb's Learning Style Inventory

MBTI- Meyers-Briggs Type Indicator

MCQ – Multiple choice questions

SAQA – South African Qualifications Authority

SDLR - Self Directed Learning Readiness

VARK - Verbal Active Reflective Kinaesthetic

CHAPTER 1

INTRODUCTION TO THE RESEARCH

1.1 Introduction

To choose a career is one of the most important decisions a young person has to make. To choose to become an occupational therapis requires dedication and a genuine urge to make a difference in the lives of people.

To become an occupational therapist tertiary education is required. Tertiary education in South Africa requires enrolment at a university. Universities aim to equip and qualify students for professional careers by improving their skills, behaviour, and knowledge.[1,2]

Occupational therapy is a degree programme taught at various universities nationally and internationally. Each one of these universities has its own policies according to which curricula and teaching methods are determined. The one common factor at all these universities is that they all aim to produce competent and knowledgeable occupational therapists.[3]

The University of Pretoria is one of eight such tertiary education facilities in South Africa where occupational therapy is presented. The programme is presented as a four-year degree that is accredited by the Health Professions Council of South Africa (HPCSA) and the South African Qualifications Authority (SAQA). The programme requires competency and personal development of students in a variety of modules and fields of practice. Most of the modules include theoretical, applied, and practical components. The curriculum is planned according to a process-based model that starts with

basic foundation modules that develop into more applied modules.[4] Knowledge and skill requirements are progressively increased over the four years of study with a strong focus on practical application.

Levels of education in present day South Africa are often different in poorer rural areas when compared to that of urban areas. Students are often less exposed to more modern and electronic resources found in urban schools resulting in university applicants with different backgrounds and experience.[4]

Language is another area of difference between the applicants. Even though English is often the second or even the third language for many applicants, the reality is that in a country where there are eleven indigenous languages it is not possible to accommodate all the language requirements. The business language in South Africa is English and thus it has become the language of choice to use in education, especially at tertiary level. Even though it is not always the home language, the language used for education in many of these schools is mainly English and/or a local language.

The lack of modern facilities and education in a second language has an impact on the level of education of these applicants from rural areas. In addition to this, the level of education is often also different because of financial discrepancies between provinces, as well as the competence of teachers.[5]

Prospective students who apply to study occupational therapy at the University of Pretoria come from both rural and urban areas. The diverse educational, social, and cultural backgrounds of these occupational therapy students studying at the University of Pretoria may result in differences in the ability of the students to cope with the new environment, rapid flow of information, and other challenges posed by tertiary education. However, the diversity of these students should be considered in a positive light as this will equip them for working in a diverse society.[6] The aim should be to achieve a

balance between the diversity and eventual competence of these students to become skilled occupational therapists.

1.2 Problem statement

In the first year of studying occupational therapy at the University of Pretoria most of the foundation modules are taught. These modules are expanded upon as the programme gradually progresses from basic to advanced knowledge and skills. One such foundation subject, taught in the second semester of the first year, is Biomechanics.

As indicated in Appendix A the outcomes of Biomechanics are focussed on understanding and applying the laws of mechanics in the environment and the human body. Initially the basic laws of physics as applied in the physical world have to be understood at an intellectual level. Thereafter reflection and problem solving should take place so that the application of these laws to the human body may be understood.[7]

Deep learning should be applied to achieve a better understanding of the application of the laws of physics.[8] This implies that the students should be encouraged to not only memorise facts but to reflect on the possible application of the knowledge. Teaching methods and approaches should thus not stagnate and should be adapted to the needs of the students.

Traditional teaching was used for many years. The researcher has taught Biomechanics to the first year occupational therapy students at the University of Pretoria over the past ten years. Gradually more blended teaching was applied. In spite of the use of blended teaching and learning the researcher has observed that there are still many of the first year occupational therapy students that find it difficult to understand some of the basic laws of physics. Insufficient grasp of these basic laws limits the ability to apply them. It has also

been observed that active participation in learning situations in class seems to assist in a better comprehension of the concepts and their eventual applications.

The question arose whether there are any other teaching methods that could be used to assist in the understanding of these biomechanical concepts and their applications.

The need to stimulate deep learning and adapt to innovative development in teaching prompted a search for additional information on learning and the elements influencing learning. Possible alternative methods of interaction with information that might assist in the learning and teaching of this subject were investigated.[9]

Some internal and external factors that may impact on learning in general were identified. The most relevant internal factor identified for this research was learning styles. Russell[9] states that more effective learning will take place when the teaching methods employed by the educator accommodate the most dominant learning styles identified in a group.[9] Educational approaches should thus ideally include an assessment of learning styles of the students. Identification of a learning style profile may lead to a better understanding of the learning and teaching needs of the group as well as individual students.[10]

Learning styles are determined with the use of different learning style tests. Studies conducted in different countries on learning styles of occupational therapy students indicate that the 'visual', 'sequential' and 'active' learning style proponents are commonly identified.[10,11,12] This implies that a more 'active' and 'visual' means of teaching might assist in more effective learning.

A search was conducted to find information on learning styles of occupational therapy students at the University of Pretoria. No such studies could be found.[13] An assumption was made that the profiles identified for occupational therapy students in other countries may be similar to that of

occupational therapy students studying at the University of Pretoria. This assumption had to be confirmed or rejected.

External factors that may have an effect on the learning and teaching requirements of these occupational therapy students studying at the University of Pretoria include:

- The diverse backgrounds that they come from. Students may represent any of the ethnic groups in, and sometimes even outside, South Africa. This implies that there may be language, cultural, socio-economic and educational differences that may impact on their learning.
- The contemporary environment they grow up in. Even though learning styles do not change over time, the learning needs of students do.[14,15,16] The students of today live in an environment where rapid changes in technological development occur. These changes should also be taken into consideration in the teaching methods used.[17]

In this day and age interaction with electronic-based information is regarded as important in the education process. Due to the availability of technology, the present day students known as y-generation students tend to spend a lot of time on computers and other electronic media and less time using books.[15] Students need to be in a position to exploit this interaction.[18]

In order to keep the interest of the students, teaching methods and learning resources have to be in step with the technological developments of the time. The increasing demand for information via e-learning poses a challenge for universities all over the world. The need to investigate the use of technology that may accommodate the learning styles and the changing needs of the first year occupational therapy students studying at the University of Pretoria when learning Biomechanics was recognised.

The University of Pretoria is already involved in many different forms of e-learning. A black board system is in use to communicate with the students on various levels.[19] As part of the need to keep up with the interactive e-learning

needs of the students the University of Pretoria encourages the use and development of interactive learning resources. The Department for Education Innovation at the University of Pretoria provides extensive facilities and support in the development of e-learning resources. The development of these interactive learning resources requires careful planning to determine whether the time and cost invested will be justified by the value added to the learning of the students.

After deliberation with the staff of the Department for Education Innovation on the feasibility of such a resource, it was decided to develop an interactive multimedia CD 'Basic Biomechanics for therapists' as a learning resource for Biomechanics as available in Appendix B.

Development of the interactive 'Basic Biomechanics for therapists' CD took five years. After completion early in 2009, it was decided to conduct this study to determine what the effect on the achievement of the students will be.

The use of such an e-learning resource was still untested for occupational therapy students at the University of Pretoria. It was uncertain whether these students would be comfortable using such a resource and if the CD will contribute to their learning.

The learning style profile of the students was assumed and had to be identified to determine if the teaching methods used in the resource would be compatible to the learning style profile of the first year occupational therapy students studying at the University of Pretoria.

The first group of students that were exposed to the resource were the first year occupational therapy students of 2009. A pilot study was conducted with the assistance of these students during the second semester of 2009 to provide a basis for this research.

1.3 Research question

Based on their learning styles, will the interactive multimedia CD 'Basic Biomechanics for therapists' have an effect on the first year occupational therapy students' learning of Biomechanics when studying at the University of Pretoria?

1.4 Research aim and objectives

Based on the research question the aim of the research was formalised.

1.4.1 Aim of research

To determine, based on their learning styles, if the use of an interactive multimedia CD will have an effect on the learning of Biomechanics by the first year occupational therapy students' studying at the University of Pretoria.

1.4.2 Research objectives

Four research objectives were identified.

Objective 1: To determine the learning style profiles of the first year occupational therapy students.

Objective 2: To determine the effect of the interactive 'Basic Biomechanics for therapists' CD on the learning, measured as achievement, of occupational therapy students studying Biomechanics.

Objective 3: To determine the experience of the first year occupational therapy students using the interactive 'Basic Biomechanics for therapists' CD.

Objective 4: To determine the possible relationship between the learning style proponents and the achievement of the first year occupational therapy students using the interactive 'Basic Biomechanics for therapists' CD.

1.5 Operational definition of terms

In order to ensure clarity of the terminology used in this research the following terms were defined.

Achievement tests: Tests developed by the researcher to use as measurement instruments for the pre- and post-achievement of the students

Approaches to learning: Students may approach learning in different ways. Some will learn to simply reproduce the information; others will see a need to understand the meaning, whereas a last group may only want to pass the course and will thus use a combination of both these methods of learning.[8]

A-synchronous e-learning: Learning with the use of the internet or a stand-alone package to be used in the students' own time.[15]

Basic Biomechanics for Therapists CD: Interactive multimedia CD that was developed by the researcher for teaching and learning Biomechanics.

Black-board system: A computer-based communication system used for the sharing of information by a large group.[19]

Blended learning: The use of a combination of traditional instructor led training including face-to-face contact, assignments, class discussions, case studies and e-learning technology for teaching and learning.[1]

Educational background: The type of schooling the student experienced. In South Africa exposure and learning opportunities in schools may differ greatly, especially between more affluent urban and poorer rural schools.[20]

E-learning: Learning done with the use of technology, for example, online, web based, computer assisted, or internet learning.[1]

Face-to-face sessions: Conventional teaching sessions during which the lecturer directly interacts with the student.

First year occupational therapy students: Students that were selected to study occupational therapy at the University of Pretoria and are in their first year of study.

Interactive learning: Learning by actively interacting with other student/s, lecturer, or resources.

CD: Computer-based programme that allows interaction with visual and verbal information in the form of the written and/or spoken word, videos, animations, photos, and sketches to illustrate concepts and meaning.[21]

Learning: An active process where a student interacts with information to increase knowledge.[22]

Learning strategies: Weinstein and Mayer in Witrock et al (1986)[23] defined learning strategies as "behaviors[sic] and thoughts that a learner engages in during learning and that are intended to influence the learner's encoding process."[23]

Learning styles: An encompassing term related to individual learning differences.[22] Identification of how information is perceived, organised, processed, and understood, to solve problems in everyday life.[8]

Module: A collection of study-units that forms a defined aspect of a subject.

Multimedia: "Two or more media such as text, graphics, animations, audio, or video"[8] used to provide stimulating learning content.

Y-generation: Students born between 1979 and 1995 during the era of rapid technological development.[15]

1.6 Significance of the study

Clarity on what should be done with the information obtained in the study had to be gained. The answers to the question had to be utilised to the benefit of the students and lecturers. These benefits will now be discussed to indicate the significance of the study.

The results of this study could be used to establish a learning style profile for the first year occupational therapy students studying at the University of Pretoria. The data collected may be regarded as the start of an on-going process. Over time voluntary participation in learning style testing could become routine for occupational therapy students studying at the University of Pretoria. The information on learning styles of the first year occupational therapy students could be published and compared to the findings of studies done in other countries.[10,12,24] Similarities and/or differences between the learning styles of occupational therapy students in each year group and globally may be identified.

Determining a representative learning style profile for the occupational therapy students studying at the University of Pretoria could provide a guide to the most effective teaching methods for these students. Such a profile, once established, may be studied further to determine whether it may be of assistance in the selection of learning resources and how it may assist in the cultivation of a deep approach to learning.

The students may benefit by the dissemination of the results of the learning style profiles. It may make them aware of how they ought to accommodate and adapt to different teaching styles.[11] Understanding of their own learning styles will assist students to accommodate the learning styles of their clients where instruction is instrumental to the occupational therapy process used for treatment. They will be able to teach and instruct their clients with the use of appropriate teaching methods to make it easier for the clients to understand what is required in therapy.[8]

The results of the study may also assist in the improvement of the interactive *'Basic Biomechanics for therapists'* CD. This CD is not the first such resource developed at the Occupational Therapy Department of the University of Pretoria for occupational therapy students. It is however the first to be studied for the impact it may have on student achievement and experience.

Change in the achievement of the students may contribute or serve as a guide for the development of other similar learning resources for occupational therapy students. The evidence-based practice tested by the research may add value to the wider applicability of the resource in other related modules and by qualified therapists. It may also add to the marketability of the resource to other universities or training facilities.

1.7 Scope and delineations of the study

In order to increase the value of the research findings it was necessary to determine the scope of the study.

1.7.1 Scope of the study

The study was focused on learning of Biomechanics by the first year occupational therapy students at the University of Pretoria. Biomechanics forms the basis for many modules taught later in the course concerning the assessment and treatment principles of physically affected clients.

In spite of the fact that there are many internal and external factors that may impact on the learning of the students, the focus of the study was the effect of the interactive multimedia resource '*Basic Biomechanics for Therapists'* on the achievement of the students. This is a measurable influence that may be generalised to other modules studied during the course.

1.7.2 Delineations of the study

The study was delineated[25] according to the following:

Only first year students studying occupational therapy at the University of Pretoria in 2010 and 2011 were included in the study.

Only the study of Biomechanics was included in the study.

Only the achievement and experience of the students were measured.

The only intervention tool that *was* used in the study was the *interactive 'Basic Biomechanics for therapists' CD*.

1.8 Layout of research

The research study consists of five chapters. A brief exposition of each chapter is as follows:

Chapter one: Introduction to the research study.

Chapter two: A study of relevant literature including the following topics:

- Learning
- External factors affecting learning
- Learning styles
- Assessment
- Teaching the y-generation
- E-learning
- Teaching and learning Biomechanics
- Development of an interactive CD as a learning resource

Chapter three: The method and process that were followed to conduct the research study.

Chapter four: The statistical analysis of the results obtained, described and interpreted according to the objectives.

Chapter five: A discussion of the conclusions concerning the research aim and objectives. Recommendations based on the findings of the study are made.

1.9 Summary

In order to obtain a tertiary education, a student has to enrol for tertiary education at a university. The University of Pretoria is a tertiary facility where

occupational therapy is presented as a four-year degree programme. One of the first year modules presented as part of this programme is Occupational Sciences (AKU 100) with Biomechanics as one of the study-units. This is one of the foundation modules required for application in other modules as well as in assessment and treatment of clients and will be further discussed in 2.8.

The researcher, as lecturer, observed that many of the first year occupational therapy students studying at the University of Pretoria find it difficult to understand and apply the concepts taught in Biomechanics. Understanding that teaching methods may need to be adapted to stimulate more effective learning, motivated the investigation of some of the elements affecting the learning of students. The main focus became the learning styles of the students and the fact that they were born in the era of the y-generation.

An interactive CD '*Basic Biomechanics for therapists*' was developed to be used as an additional educational resource to teach Biomechanics. After completion of this CD questions were raised about how effective it would be in addressing the problems that the students experience in learning Biomechanics. It was decided to conduct this research to answer these identified questions.

Four objectives were identified to provide answers to the questions asked. The answers to these objectives may assist in the development of other similar instruments for the Occupational Therapy Department, adding to resources used in other modules. Determining the learning style profiles of occupational therapy students may also add to the planning of teaching and learning approaches for these students.

This study was conducted at the Occupational Therapy Department at the University of Pretoria. The students participating in the study were delineated to the first year occupational therapy students studying at the University of Pretoria in 2010 and 2011.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this day and age education as a basic human right is paramount and non-negotiable. Approaches to education need to evolve with the constantly changing environment in order for the future generations to be able to effectively fulfil their roles in society. The challenge for educators is to remain in touch with the changing environment and to timeously adapt teaching styles and techniques to the contemporary learning needs of the students. This implies an appreciation for the advantages that technology can bring to the table whilst at the same time acknowledging the requirement to take into consideration divergent educational backgrounds as well as learning styles.

Learning develops from a young age. It is important to understand this development process of learning in order to be able to assess if learning has taken place successfully. This learning development process may be stimulated or limited by different external and internal factors.

This research study is focused on learning at a tertiary level and more specifically the learning of Biomechanics by first year occupational therapy students studying at the University of Pretoria. A closer look will be taken at the development and assessment of learning and the possible teaching methods that may improve learning. Factors influencing learning will be discussed in the following order:

Learning: Factors that shape and influence learning in individuals are discussed. The learning demands for occupational therapy students are

investigated and the relevant elements affecting the learning of these students are explained in more detail.

External factors influencing learning: The different external factors that may impact on the development of learning are identified and discussed in short.

Learning styles: A closer look at the effect of the learning styles on learning is taken. The development of learning style tests and the use of some of these tests are described. Learning style profiles of occupational therapy students as found in literature are studied and compared.

Assessment of learning: The methods and application of assessment of learning are explored. Assessment as applied in the development of the measurement tools for the study is discussed.

Teaching the y-generation: The effects that the technological era have on the learning and teaching needs of students.

E-Learning: The use of e-learning as a teaching and learning tool is described and investigated.

Teaching and learning Biomechanics: The challenges of teaching in general and more specifically teaching Biomechanics to the first year occupational therapy students are explained.

Development of an e-learning resource: The process and requirements for the development of an interactive multimedia CD are described.

2.2 Learning

Learning is: "the act, process, or experience of gaining knowledge or skills." (Conner)[26]

Learning takes place both formally and informally throughout life. To become a successful and motivated student, a positive attitude towards learning has to be cultivated from a young age. Development of learning is influenced by different external and internal factors resulting in learning habits being formed. These learning habits cultivate individual strengths, interests and abilities.[27]

When students enrol for tertiary education it is assumed that a certain level of knowledge is already in place. A desire to expand on this knowledge to obtain a qualification for a specific career is present. The ability to achieve success at this tertiary level will be determined by the individual's inherent abilities as well as the learning habits that were developed during childhood. These learning habits are influenced by the environment the individual is exposed to.

First year occupational therapy students may be from any of the ethnic groups in South Africa. This implies that different home languages, cultural influences, educational backgrounds, differences in environments and academic skills may be present.[5] All these factors have had an influence on the development of learning habits. Added to these external factors, the inherent learning styles and intellectual abilities of the students will impact on the success of learning.

These internal and external factors may impact on what kind of environment and method of information transmission occupational therapy students will be most comfortable with.[5] Some factors that are regarded as possible influences on the learning needs of the students that participated in this study will be discussed.

To understand the first year occupational therapy students better, it is necessary to first understand how learning in general develops and what factors in the development process may have impacted the learning habits of these students.

2.2.1 Development of learning from birth to adulthood:

Interest in the development of learning has kept researchers in different fields of study occupied for many years occupaied. Each one of these researchers approached learning from the perspectives of his or her field of study. Collectively all these sciences contributed to a better understanding of the development of learning, the transmission of knowledge and factors that may impact on learning.[28] Even though there are different opinions in some areas and consensus in others, for the purposes of this study the theories describing the development of learning will be assessed according to a generalized description by a limited selection of researchers.

Developmental and Educational research as described by Bransford et al[27] confirmed the findings of various neuroscientists who established that learning patterns are formed in the brain and that these learning patterns expand as the child develops.[27]

Babies are born with their inherent personalities and intellectual abilities already present. Starting at birth, interaction between the individual and its environment results in physical, emotional, social and cognitive learning, all of which take place at the same time complementing each other.[29]

Gregory[29] and Jindrich[30] are in agreement that the first ten years of life are critical in the development of learning patterns. Brandsford et al[27] adds that the amount of stimulation the child gets from its environment contributes to the optimal development of its learning abilities.

Types of learning: Development of learning in these first ten years takes place on different levels of functioning. This learning development will be discussed as four different types of learning. It should be remembered that there is no time difference between the developments of these types of learning. Siemens[28] emphasises that they are interwoven with each other adding to and complementing each other.

Physical learning: The first type of learning to be discussed is physical learning. Physical learning is described by Jindrich[30] as sensory-motor learning. It is the first recognised development of learning to be described and commences at birth.

Part of this physical learning is the development of motor control. Motor control starts at the head and trunk resulting in controlled function of the limbs. When gross motor control is in place, fine motor development becomes possible. New motor function patterns are learnt and refined throughout life.

The stimulation that a developing child receives from the environment assists in the development of physical learning. A child learns to feel safe and to love itself in a loving and stimulating environment. This results in a feeling of safety that leads to physical exploration stimulating more motor development as well as emotional control. The child learns to have confidence and to problem solve on its own.[28]

Social learning: Another type of learning that develops from a young age is social learning. Social skills are developed by watching and copying the behaviour of others. A sense of self gradually develops enabling successful interaction with the environment and others. Bransford et al[27] states that the younger child is initially very dependent on acceptance and praise from parents, educators and adults. Gradually this dependence changes to a need for acceptance by the peer group. Peer influence becomes especially strong between ages 13-18 years.

Cognitive learning: A further type of learning at this early stage is the development of the genetic intellectual capabilities and talents that each child is born with. The development of these intellectual and cognitive abilities is encouraged or suppressed by the environment and has been studied by different researchers. Only a few of the findings, as representative

of the larger school of thought on cognitive thinking, will be included to clarify the understanding of this type of learning.

Bransford et al[27] and Jindrich,[30] agree that intellectual and cognitive learning develop according to a predictable sequence. This includes pre-logical intuitive thought, the start of problem solving, critical thinking and language skills.

Gregory[29] claims that a child will start identification and basic recall of a single absent object at an early age. Over time this recall and identification increases, expanding the ability and capacity of memory. This leads to the processing of basic principles stimulated by input from different settings in the child's environment.

Language skills gradually become the vehicle of logical thinking. A concrete level with auditory functions represented by verbal commands becomes an important part of learning.[29]

Thomas[31] posits that many lower order mechanisms become replaced by higher cortical functions. Basic abilities become advanced reasoning leading to the ability to solve more complex problems and situations. Concrete mental images are formed and a realistic imaginary world becomes possible. The development of the ability to use symbols to describe concepts, changes the learning process to more than visual and auditory input. Gradually problem solving, critical thinking, and language skills develop into the ability to not only repeat information but also to integrate, reflect, and find solutions. This constitutes the start of deep learning.[26,32,33]

Active learning: The last type of learning to be mentioned is referred to as active learning. Gallew[3] and Gregory[29] agree that some learning takes place by observing and some by doing. From a young age learning by doing things establishes knowledge better than only observing, reading or hearing about it.

Physical learning can only be developed by doing e.g. learning to ride a bicycle is only possible if you physically get on the bicycle and ride it. The effectiveness of active participation is also true for other types of learning like cognitive learning, such as, counting e.g. counting physical objects. Active participation is thus an effective method for learning and is used in most knowledge acquired by children.[30]

As the child develops, the preference to do will remain strong in some, while others will prefer to observe or question by reasoning. These preferences indicate that learning styles are already in place at an early age. A person's learning style, intellectual differences, and interaction with the environment will thus influence his or her ability to interpret and use information.[29,30]

2.2.2 Adult learning:

"the process of adults gaining knowledge and expertise"

(Knowles et al)[2]

By the time young people enter into tertiary education they learn in a more adult manner. The fact that a career has been chosen, makes them more self-directed, goal-directed, and mostly highly motivated.[2,3,27] The knowledge gained should thus be meaningful and bring the goal closer. This goal-directedness in learning makes students less tolerant of an education system with rigid rules. There is a need for self-direction and leadership in their own learning process.[34,35] This need for self-directedness also leads to different approaches to learning.

Approaches to learning: Three approaches to learning namely the surface, deep and strategic approaches will be discussed.[36] The particular approaches to learning adopted by the student determine the manner in which the information will be internalised. Approaches to learning should not

be confused with learning strategies which indicates rules and procedures according to which learning is organised.[8] Edwards[37] stated that a mismatch between the approach to learning and the required learning task may have a negative impact on learning outcomes. A sense of dissatisfaction may be experienced in situations where such mismatches exist, resulting in students becoming discouraged.[37]

Three approaches to learning are described as follows:

Surface approach: Case[32] and Ross et al[33] both describe the surface approach as memorization of facts with no attempt to fit these facts into the larger picture. It allows for the reproduction of information with no insight or understanding.

Surface learning will allow partial recall of the facts for a short time and is usually used for crash studying before tests and exams. The intention of surface learning is to pass the test or exam in order to satisfy the requirements of the course.

Deep approach: Once again Case[32] and Ross et al[33] are in agreement that an intellectual curiosity is present in a deep approach to learning that leads to an urge to understand and analyse information. Information is probed, questioned, and possible applications are considered and identified. It often includes higher order processing and reflection that may lead to application of knowledge and to find solutions to problems. Information can be explained, argued about and related to. Understanding, retention, and recall of the content that was learnt by using this approach will be possible for an extended period of time. It will be possible to expand on the knowledge gained and to apply it to various situations.

Strategic approach: Felder et al[8] describes the strategic approach to learning as a mixture of surface and deep approaches. The main aim is to achieve top marks. The amount of effort needed is carefully assessed and only the necessary will be done according to whatever is perceived will

achieve the highest grade. The result being that some of the information will be learnt as surface knowledge to reproduce for the short term, while other knowledge will be learnt according to the deep approach in order to make application possible.

It is important to encourage occupational therapy students to cultivate a deep approach to learning in order to become competent and skilled therapists. The learning requirements of occupational therapists will be discussed next to explain the need to cultivate a deep approach to learning.

2.2.3 Learning requirements of occupational therapy students

The training of competent, knowledgeable and caring occupational therapists that are lifelong learners is and remains a challenge.[3] Thus, in order to understand the relevance of the development of learning, especially adult learning, it is necessary to understand what the learning requirements for occupational therapy students are. It is thus necessary to have a better understanding of what occupational therapy entails.

Occupational therapy in essence is "a health profession whose goal is to help people achieve independence, meaning and satisfaction in all aspects of their lives".[38] A broad description of occupational therapy includes the following:

Occupational therapists must apply specific knowledge in the treatment of their clients who have an injury, illness, disability or psychological dysfunction. They make use of evaluation and treatment in order to enable their clients to achieve participation in meaningful activities of daily living. Family and caregiver consultations are employed to promote the client's capacity to participate in these meaningful activities in their own environments. The

clients are provided with skills to function in their work and leisure environments where applicable.[38]

In order for occupational therapy students to perform all these expected tasks, it is imperative for them to be able to reflect on and integrate information. The best suitable treatment and ultimate achievement of meaningful occupation for the clients to be treated will then be possible. The need to integrate information emphasises the need for cognitive maturity and a deep approach to learning where information is interpreted and integrated with other information in context.[8,39,40]

It is important to stay abreast of new developments in the occupational therapy field of practice. Continued education is thus important and required by the Health Professions Council of South Africa (HPCSA) for continued registration as a healthcare professional. A deep approach to learning contributes to the necessary commitment to acquire new knowledge throughout life.

The importance of deep learning for the qualified occupational therapist is emphasised in a study done by Svidén[36] to assess the approach to learning of occupational therapy students.

Svidén[36] conducted a qualitative study in 2000 into the approach to learning by occupational therapy students that attended a course in Sweden. The conclusion of this study was that occupational therapy students tend to apply a surface approach to learning and do not have sufficient development of deeper learning approaches.

Other studies looked at how deep learning may be stimulated in occupational therapy students. A study done by Gallew[3] in 2005 on "learning through doing, being and becoming" emphasised the importance of developing teaching methods where deeper learning is stimulated.

The occupational therapist is challenged to apply problem solving and to have good interpersonal and leadership skills. The therapist must 'do' by preparing, planning and implementing the information needed. When the information is taught to the relevant recipient the doing becomes 'being'. 'Being' implies the therapist must experience the role of being the educator by applying critical thinking and analysis to situations and information. When the previous two phases are successfully engaged in, the 'becoming' will follow automatically. The therapist will 'become' the educator and be able to engage in a deep learning approach.

The findings of this study as described by Gallew[3] were confirmed in a study conducted by Martin et al[40] who found that clinical experience is a very valuable resource to achieve deep learning. Both these studies emphasise the need for active participation in the learning process in order to achieve deeper learning.

When considering the education of occupational therapy students the need of the adult student for self-directedness should be exploited to stimulate more effective learning. Teaching methods should stimulate integrated learning and thinking. Practical application of knowledge in solving problems through active participation and dialogue should be encouraged. Diverse sources of information should be used to stimulate critical reasoning. Ruiz et al[1] states that regular feedback and self-evaluation provide further motivation for self-directed learning. The effectiveness of motivating students to apply a deep approach to learning will be increased if the identified learning styles are taken into consideration.[8]

2.3 External factors affecting learning:

The diversity of the students studying occupational therapy at the University of Pretoria as mentioned in 1.2 portends that different factors in the environment of the student may impact on the development of learning. To enhance the understanding of the specific students participating in this study, it is necessary to look at some of the factors that may have an impact on their learning. These external factors include culture, socio-economic background, language, etc.

Understanding the development process of learning makes it clear that the environment that the student grows up in is of great importance. A closer look will now be taken to identify the possible impact that some of these external factors may have.

2.3.1 Culture as a factor

The effect of culture on learning has been studied by different researchers. According to Alder et al[41] the learning of social skills, values and beliefs are learned especially through exposure to the culture that the child grows up in. In the emotional development of the child, the environment that the child grew up in will impact on the eventual self-confidence of the individual.

In some cultures adult responsibilities are expected from the young person as soon as puberty is reached. Hammersley[42] argues that cognitive and emotional learning contribute to the ability of the young adult to cope with this period of transition and excessive responsibilities should not be demanded too soon.[42] These adult demands could prove to be too much for these young adolescents as they have not yet developed the emotional

maturity and experience required to be able to cope with these responsibilities. This may lead to a feeling of inadequacy and frustration.[42]

Cultural differences may also result in a different approach to learning. A study done by Watson et al[43] with occupational therapy students from two different cultures looked to identify a possible difference in approach to learning. Students from Bangladesh and the United Kingdom took part in this study. The assumption was made that the impact of cultural differences may have an influence on how interaction with the environment, learning materials, and the method of delivery of the material takes place. This assumption was confirmed by the results of the study. The most important difference was observed in the approach to learning.[43] The study concluded that the differences observed between the two groups did not result in one group being more successful than the other. The process of getting to the end goal was just reached in a different way.

It is important to be aware that cultural background may have an impact on learning, but it is more important to ensure that the outcomes for the subject i.e. Biomechanics, must remain the same for all students. To achieve this, the context created by the educator must be the same for the whole group and should be inclusive of the requirements of deep learning. Stereotyping of cultural groups should be avoided and cultural diversity should be regarded as desirable for the growth of the profession.[43]

2.3.2 Socio economic factors

According to Porter[44] children that grow up in a low income household may be more prone to illness due to insufficient nutrition, resulting in absence from school. The learning opportunities of these children are often inhibited leading to lower achievement at school, resulting in fewer employment opportunities.[44]

Balfour et al[5] portends that Outcomes Based Education (OBE) and other participatory education methods that have been used in South African schools over the past two decades, resulted in the education of the children in the poorer areas, especially in poorer rural areas remaining beset with problems not anticipated in policy initiatives. Chikolo[45] adds to the opinion of Balfour et al[5] by stating that people living in these poorer rural areas are often socially excluded from participation in socio-political activities in the country. There is often a lower level of education among adults and inferior quality education in many of these poorer schools. Rural and poorer schools are often also under-resourced. In comparison to the much neglected rural areas the poorer urban areas may at the very least have better infrastructure and possible assistance that may make a difference.

A study done by Taylor as cited by Chikolo[45] on the South African mathematics matriculation results in 2006 found that 80% of schools are dysfunctional. Most of these are the schools situated in rural areas serving black students. This is attributed to the limited abilities and motivation of the teachers and the lack of developmental stimulation in the students.

Some of the students educated in these poorer rural schools have the intellectual abilities and motivation to enrol for tertiary education despite the abovementioned disadvantages. These students often find it difficult to adapt to tertiary study requirements and often need extra time to bridge the gap between themselves and their fellow students.

2.3.3 Language as a factor

To learn in a language other than your mother tongue is a challenge. As discussed in the development of learning Gregory[29] and Chikolo[45] concur that it is not ideal to be taught in a second or even a third language because there is a close link between logical thinking and language. [29]

According to Alexander (cited by Chikolo)[45] education presented in a second or third language will produce second or third rate citizens. Despite this the dominant business language of the 21st century is English. This creates a justifiable and understandable desire by most to become proficient in English. The fact also remains that the majority of text books and other learning material are often only available in English resulting in a large percentage of teaching taking place in a second or third language.

Summary: Three factors affecting learning were discussed. These are not the only external factors that may have an impact on the learning development of students. For the purposes of this study it will however be the only factors included and considered. It was mentioned in 2.2.1 that there are also internal factors that affect the development of learning. The most relevant internal factor, concerning this study that may impact on the learning development of the students is learning styles.

2.4 Learning styles as an internal factor affecting learning

Learning style is the dynamic process of learning of an individual, which includes the processing of information as well as personality theories and social interaction.[46]

In the discussion on the development of learning it became clear that each individual learns differently. Learning is influenced by external environmental factors and internal individual abilities e.g. vision, hearing, ability to reason logically, reflection, intuitive memorization, visualisation, and drawing of analogies.[27,29] All these factors as described in the types of learning that influence learning and will have an impact on the achievement of an individual.

According to Katz[47] the specific method of interaction with information that each student prefers will depend on their learning style and other elements such as the instructional circumstances, and interaction with fellow students and educators. Amin[48] added that insight into the different learning styles of the students may assist the educator in adopting appropriate teaching methods to accommodate the majority of learning styles represented by the students studying a specific programme.

Considering the elements needed for teaching and assessment, Lazear[49] found that paradigms that promote the belief that people learn only by repetition, and that all students are basically the same, are not applicable or accurate any more. The acknowledgement of these differences in learning confirms the need to develop methods to identify the learning styles of students. Armstrong[50] thus suggests that the paradigm of using the same methods of teaching, learning, and assessment for all has to be questioned. The identification of the students' learning styles should, however, not be regarded as an indication for change to the method of instruction. It should rather be regarded as providing additional insight in the development of the instructional design. It should be used to provide a frame of reference to the educator to accommodate and understand the learning needs of the students in a group.[51]

Learning styles cannot predict whether students will be effective learners. In the professional world of tertiary education the students will need to be able to adapt and add to their own way of integrating information to maximise learning in spite of the teaching method.

Making students aware of their own learning styles will provide them with insight into their own strengths and weaknesses. In order to learn more effectively they should be able to identify methods to adapt to the instruction received when exposed to instructional methods other than their own preferences.[8]

2.4.1 Development of learning style tests

The need to identify the methods of learning and thus the learning requirements of students according to their inherent characteristics was identified early in the 20th century. During this century 71 learning style instruments were published.[52] There is still, however, no framework or definitions that can be used to identify the different learning requirements of individuals.

Carl Jung was one of the first to identify terms to describe properties of learning. Some of these terms are still in use.[8] Based on these terms identified by Jung, Myers-Briggs developed one of the first widely recognised measurement instruments namely the Myers-Briggs Type Indicator (MBTI) in the early 1940s. The MBTI mainly identifies personality tendencies but is also known to have strong learning style indicators. It is claimed that the MBTI indicator could be used to indicate career preferences, aptitudes, management styles, learning styles, and behavioural tendencies.[53]

Since the introduction of the MBTI various other researchers such as Kolb, Gregorc, De Bello, Felder and Silverman, to name but a few, have studied methods of learning over many years.[51,54] This led to the development of different learning style measurement instruments. The lack of a common framework resulted in most of these learning style measurement instruments covering similar ground but without the use of common terminology. This has resulted in confusion for those who set out to determine learning styles. Because of this lack of a singular definition and construct researchers like Swinton[55] and Gregorc as cited by Gould et al[54] questioned the usefulness of these tests developed to determine learning styles.

To illustrate the difficulty that the different terms created, the terms to identify learning proponents as used by some of the researchers relevant to this study are summarised in Table 2. 1.

TABLE 2.1: Summary of learning style terms used by different researchers

Terms used to describe learning style proponents	**Jung**[8]	**Meyers-Briggs**[8]	**Kolb**[56]	**VARK**[57,58]	**Felder and Soloman**[53]
Active external processing of information	Extraversion	Extraversion	Active experimentation	Kinaesthetic	active
Internally directed processing of information	Introversion	Introversion	Reflection and Observation		reflective
Processing depending on external information	sensing	sensing			sensing
Processing depending on internal information	Intuition	Intuition	Concrete experience		Intuitive
Decisions made according to logic	Thinking	Thinking	Abstract conceptualisation		(Deductive) removed in 2004
Decisions made on emotion	Feeling	Feeling	Concrete experience		(Inductive) removed in 2004
Information organised according to linear thinking		Judging	Abstract conceptualisation		sequential
Information organised according to improvising		Perceptive	Active experimentation		global
Method of Interaction with information received visually				visual	visual
Method of Interaction with information received auditory and printed word				Aural Read/write	verbal

Different themes are observed in different learning style tests. Some, like Myers-Briggs focus on personality traits, others like Kolb focus on the

processing of information or the senses are the focus of the measurement as used by Fleming as cited by Brown et al[46]. This tendency to focus on one aspect of learning may lead to more compartmentalisation that limits the value of the identification of the learning styles. Ideally a combination of all three themes will provide more comprehensive insight into the learning style profile and the teaching needs of students.[59]

Controvecy also still exists in the belief by some researchers that learning styles are 'fixed' whereas others believe learning styles can change over time. Individualised teaching according to a 'fixed' learning style has been severely criticised in the literature by a researcher like Sthal as described by Litzinger et al [52] due to the lack of evidence that improvement in learning took place. Some recognition of the positive impact on learning by a more flexable trait that encourages self-development was reported.[59]

One of the learning style instruments often found to be used in studies done relating to occupational therapy students is the Learning Style Index (LSI), developed by Kolb in 1980. The terms included in this instrument represent a combination of terms used separately by other instruments to identify learning proponents. Further combination of the identified proponents' takes place to identify four learning domains.[46]

Kolb's Learning Style Index (LSI): The Learning Style Index (LSI) was developed by Kolb in the 1970s and revised in 1980. It is a self–description test that measures the strengths and weaknesses of students.[60]

The test consists of nine sets, of four words each. The four words have to be placed in order of preference. The results are then placed into four columns and linked to four learning abilities or domains. Scores are interpreted according to these four learning domains.[60] The words used in each set of questions indicate what qualities are being measured. These learning abilities are as follows:

- Immediate concrete experience (CE): receptive, feeling, accepting, intuitive, present-orientated, and experience.
- Reflection and observation (RO): tentative, watching, observing, reflecting, and reserved.
- Abstract conceptualisation (AC): analytical, thinking, evaluative, logical, conceptualisation, and rational.
- Active experimentation (AE): practical, doing, active, pragmatic, experimentation, and responsible.[60]

The identifying words used in the test simplified the comparison to other similar tests because they identify what is measured e.g. doing = active student.

According to Kolb[61,62] all four these learning abilities or domains have to be present in the learning process. In most students one or more of these learning abilities are more dominant. Dominance is measured and interpreted to indicate personality traits, learning preferences, and teaching preferences.[61,62]

Four basic learning domains are identified according to the measurement of the dominant learning abilities or proponents. These four learning types or domains are described as follows:

- Converger: Dominant in AC and AE. Strength lies in practical application of ideas. Knowledge is organised in such a way that the student can concentrate on a specific problem. They focus on a narrow technical interest and prefer to deal with things rather than people.[60]
- Diverger: These students have strong CE and RO measurements making them strong at imaginative ability. They are good at generating ideas and show interest in specialised arts.[60]

- Assimilator: Dominant abilities are AC and RO making them strong in creating theoretical models. They are more interested in abstract concepts than practical use. They are often strong in research and planning.[60]
- Accommodator: Strengths are in CE and AE. They are strong in doing and carrying out plans and experiments. They tend to be more risk-takers and excel in situations where they must adapt. They solve problems by trial and error relying on information from others. They are comfortable in "action-orientated" jobs.[60]

Validity and Reliability of the LSI test: The validity and reliability of Kolb's LSI test was studied by Ruble and Stout (1994).[60] The conclusion of the study was that the Kolb LSI tests is deficient in reliability and construct validity. It also indicated that insufficient measurement of learning styles are provided for. A recommendation that the use of this test for determining learning styles should be discontinued was made.[60]

Alternative instruments: The lack of the measurement of instructional preferences in Kolb's LSI instrument was recognised leading to researchers like Fleming as cited by Brown et al[46] to develop other instruments. The development of the 'verbal', 'active', 'reflective' Kinaesthetic (VARK) test by Fleming in 1987 [46] is aimed at the measurement of the teaching preferences of students.

Other instruments described in the literature related to occupational therapy students was the Self Directed Learning Readiness (SDLR) test developed by Gugliemino (1978).[34] Both the VARK anD SDLR tests were combined and compared to that of Kolb's LSI. It became clear that the researchers found the results obtained from Kolb's LSI, VARK or the SDLR tests on their own as insufficient. Research questions were not answered fully resulting in more than one instrument being used.[34]

Another learning style instrument relevant to this study is the Index of Learning Styles (ILS). Felder and Silverman[51] developed in the late 1980s. The terms used in the instrument were based on those used by other researchers like Jung and Myers and Briggs.[51] The similarity of the terms used resulted in easier comparison of the findings of some other instruments. According to Felder[51] there is general consensus that learning depends on the most effective means of reception and processing of information. Reception is the way that the information is transmitted and received by the students. According to these two recognised elements of basic learning, requirements were established for the construct of a learning style measurement instrument. Processing being the interpretation and assimilation of the information received.

The different aspects of learning namely; cognitive learning; thinking; and teaching were incorporated in the terminology used for most of the different learning style instruments.[54]

Until such time that common terminology can be agreed upon, the interpretation and use of different learning style instruments will to a large extent remain limited. The lack of commonality will limit the ability to compare findings of research studies unless the same measurement instrument is used.

There is not one single learning style measurement instrument that is universally accepted as yet. It is unlikely that there will be such an instrument in the near future because of the intrinsic differences between researchers.

Felder-Soloman Index of Learning Styles (ILS): The Index of Learning Styles (ILS) test was originally developed after a study conducted in New York on engineering students with the use of the Kolb LSI test by Felder and Silverman.[51,53] The aim of the study was to determine the teaching needs of these engineering students due to an identified disparity between learning styles and teaching styles that existed at the time. The learning styles of the

engineering students identified by the Kolb LSI test were found to be Abstract Conceptualisation and Active Experimentation. The Kolb LSI test once again was found lacking in the identification of teaching preferences, thus the development of the Felder-Soloman ILS was initiated.

Based on the learning dimensions described and used by Kolb, Myers-Briggs, and Jung[8,53,62] five learning dimensions were identified. Each dimension consists of opposite proponents. The five different learning domains identified were:

- 'active'/'reflective'
- 'sensing'/intuitive
- 'visual'/'auditory'
- 'inductive'/'deductive'
- 'sequential'/'global'.

A corresponding teaching style for each preferred learning style was suggested. Wide reaction in the engineering field was elicited by this study and the self-scoring web-based ILS test became very popular even though it had not yet been validated.[8] A disadvantage inherent to this test was identified in the thirty two (32) possible combinations of the learning proponents. It translated into an almost impossible scope of variables for educators to accommodate. Two changes were made to the instrument in the early 1990s.[63] The inductive/ deductive dimensions were dropped because tertiary education automatically requires the use of more deductive teaching starting with basics and proceeding to application. This removes the importance of the possible student preference for inductive learning. Thus the initial five domains were reduced to four in 1991.[63] Another change that was brought about was the renaming of the 'visual'/'auditory' dimension to 'visual'/'verbal'. Visual learning includes pictures, diagrams, animations, etc. verbal learning includes the spoken and the written word. Cognitive scientists established that the brain converts the spoken and the written words into the

'verbal' equivalent, thus spoken and written words are included in the same category.[63]

Two opposing proponents were identified for each domain of which only one proponent could be dominant.[63] The proponents that formed the four domains were:

- 'active'/'reflective'
- 'sensing'/'intuitive'
- 'visual'/'verbal'
- 'sequential'/'global'[77]
- Learning and instructional preferences are accommodated by the dimensions of this test. The information could thus be used in the planning of teaching methods without the need for additional learning style tests.
- The Felder-Soloman ILS test, available in Appendix C, consists of 44 questions that are answered in a dichotomous manner. Eleven (11) questions are allocated to each of the four learning style domains. The questions could be answered as 'a' or 'b' options, the 'a' options having positive and 'b' options negative values. The number of positive or negative replies is then subtracted from each other resulting in a positive or negative result. This result indicates the more dominant of the two proponents as illustrated in the example of the learning style results in Appendix D. The values are reflected as positive or negative values on a linear scale. Scoring and interpretation of the ILS test may be done electronically.[64]

Felder emphasises that learning style tests only suggest behavioural tendencies. The four dimensions of the Felder-Soloman ILS are to be considered as a continuum and not as separate either/or proponents. Each proponent represents a different characteristic of learning e.g. cognitive, psychological behaviour, and effect. For identification of the learning style profile all these proponents should be determined. Each dimension is

reflected by a degree of intensity to differentiate between the preferences of the student.[64]

The reliability and validity of the Felder-Soloman ILS test were researched and documented by different researchers.[64,65] The most recent validation was done in 2007 by Litzinger et al.[52] The test-re-test method was used for the statistical analysis. The Chronbach Alpha Coefficient, and Inter-scale correlation tests found p=0.05 and even as low as p=0.01 for some of the items indicating significant reliability and validity. The findings were consistent over a large population of engineering students from different Universities. [63,52]

The teaching and learning preferences included in the ILS test comply with the requirements of this research. The significant validity and reliability of the ILS test indicated that it may be the appropriate measurement instrument to utilise for this study.

2.4.2 Occupational therapy students and learning styles

The relevance of learning styles to the optimal learning and teaching of occupational therapy students has been recognised and studied by various researchers.[10,11,12,66] These studies were conducted in different settings and were done for different reasons. Titiloye[10] studied three urban based groups in Brooklyn[10], Katz studied a group in Israel[11], Weiss[66] did another study in Israel, and two more studies were conducted by French et al[12] and Brown et al[46] in Australia.

The Kolb LSI test was used as measurement tool in four of these studies.[10-12,46] There were variations in the findings but one common category was identified as the most preferred by all. This was the convergent category which translates into a combination of Active Conceptualisation and Active Experimentation. [10-12,46]

The study done by Weiss[66] used the Felder-Soloman Index of Learning Styles (ILS) test. The learning proponents identified by this study were 'reflective', 'intuitive', 'verbal' and 'global'.

Another learning style measurement test used in a study conducted for occupational therapy students by Emery et al[58] is the Self-Directed- Learning Readiness Scale (SDLRS) developed by Guglielmino in 1978. This study was conducted with Hispanic occupational therapy students in the USA. Emery et al[58] found the learning preferences of these students to be 'organising', 'personalising', 'doing' and 'imagining'.[58] The results were expressed in terminology different to other learning style instruments, making comparison difficult.

These studies provided a basis for a possible learning style profile for occupational therapy students. Interpreted according to the learning style terminology identified in Table 2.1 the strongest preferences identified by all the studies done with the Kolb LSI were the 'active' or 'extraversion', 'sequential', and 'deductive' or 'thinking' proponents.[10-12] The most dominant learning proponent identified by the Felder-Soloman ILS was the 'global' proponent.

One of the studies done in Australia by Brown et al,[46] identified the need to include the instructional preferences of occupational therapy students.[46] The use of the Kolb LSI on its own was found to be insufficient for identification of instructional preferences. The VARK test was conducted additional to the Kolb LSI to obtain information on teaching preferences. Instructional preferences according to this test were identified as 'Kinaesthetic' and 'multi-modal' indicating the preference of more than one type of instruction.[46]

Gaining a better understanding of the learning styles of occupational therapy students assisted in an improved understanding of the learning and teaching needs of these students. New insights and theories on learning style

tests are still being explored and tested and will hopefully eventually result in a more uniform description of learning styles.

2.5 Assessment

In order to measure the effect of teaching it is necessary to assess learning that took place. Many paradigm shifts took place over time as the demands of the students changed. A brief look at the history of assessment and how it has evolved as described by Thielfold et al[15] and DeMille[16], provides some insight into these paradigm shifts that took place over time. Assessment paradigms like those of learning that promote the belief that people learn by repetition and that all students are basically the same are no longer applicable in tertiary education.[41] Insight into the differences in individual learning styles, intellectual ability, and other factors that may influence learning as discussed in 2.3, formed part of these paradigm shifts. The changing environmental and social demands thus resulted in a reassessment of the methods and purposes of assessment.[50]

The theory described by Gardiner as cited by Armstrong 2009[50] on multiple intelligences revealed a new understanding of the potential of students as a multidimensional phenomenon present at multiple levels of one's brain.

2.5.1 Uses and Purposes of Assessment

Assessment forms an integral part of learning and according to Erwin[67] it may be used for different purposes, i.e. to determine the economic value of education. A parallel may be drawn between outputs in business dependent upon input in education.

Dreyer[68] agrees with Erwin[67] and adds that assessment is also often used to determine competence and potential at the beginning of the training of a professional. It serves as a guide for educators and students, enabling them to account for learning that have taken place. It contributes to learning and the measurement of progress. The results obtained from assessment provide students with formal qualifications. Assessment is thus used as an effective vehicle for training and preparing individuals for successful employment.

Assessment assists in the identification of learning difficulties or instructional shortfalls. Miller et al[69] contends that assessment should not take the place of learning, it might cause the student to only focus on the things that are assessed and no deeper learning will be stimulated.[69]

The purposes of assessment are closely linked to the different learning frameworks developed by different researchers. Even though many of these learning frameworks are available only one of these frameworks namely Bloom's taxonomy will be discussed for the purpose of this study.

Bloom's taxonomy as cited by Hagstrom[70] was first introduced in 1956 and has been adapted over time. It became a widely used framework that emphasise the need to stimulate deep learning and not only surface learning.

2.5.2 Types of assessment:

Five types of assessment were identified by Bloom's Taxonomy as described by Hagstrom: [70]

- Baseline assessment: Done at the start of a course to determine the level of knowledge of the students before teaching commences.
- Formative assessment: May be used to motivate the students by assisting them to master the content. It may be integrated with the

teaching process to stimulate deeper learning by the use of reflection on and application of content.

- Summative assessment: Is usually used at the end of a course. Classification according to the content of the course is done to determine if students are ready to proceed to the next level or qualify at the end of a course.[35,69]
- Diagnostic assessment: Identify possible problem areas.
- Performance assessment: Requires integration of knowledge and skills in the context of producing something, solving a problem or presenting a case.
- Innovative assessment: Enhances and enables self-regulated learning rather than merely being justification, limitation and measurement.[35,69]

The application of most of Bloom's taxonomy on assessment as applied in the questionnaires included in the interactive multimedia CD relevant to this study will be expanded on in 2.5.4 and 2.10. The only type of assessment not included is the Summative assessment.

2.5.3 Rules of assessment

To avoid pitfalls all assessment should be planned carefully. There are certain rules described by various researchers e.g. Miller et al[69] and Kinfoil[35] that should be considered in any assessment to ensure that the assessment is fair and will provide useful information to the student and the lecturer. The following general rules should be applied.

- Instructional goals should be defined and the purpose of the assessment should be known.

- The outcomes to be assessed must be clear and it should clarify the nature of the outcomes and provide short term goals.

- The procedure or method to be employed must be specified.

Feedback should be provided on the usefulness of the instructional materials, the effectiveness of instructional methods and the results must benefit the student and the teacher.[67]

- Maximum performance should be measured with the focus on success and not on failure, it should celebrate learning.

- Language ability of students is a very important factor in assessment. A common language should be developed in class between the lecturer and the students to be used during assessment. This will reduce possible confusion in the interpretation of the questions asked during assessment.[35]

Assessment should be a direct teaching and learning experience. It should be authentic and should answer questions that are typically asked when the discipline is mastered. Lazear[49] concludes that authentic assessment on an individual level takes into consideration the leaning style, aptitude and interest of the student. It should not rely on classroom experience alone but should elicit higher order thinking in the learning process as a whole. Information should be gathered over a period of time during which the student's abilities are assessed while integration of learning takes place.[8,49] Tasks should be meaningful to enable the student to excel. It should challenge good knowledge and require good use of judgement.[48]

In the description of the development of the measurement tools that are needed for the research the general rules described here will be supplemented, to strengthen the validity and reliability of the measurement tools.

Methods of assessment may include case studies, presentations, assignments, simulations, role plays, portfolios, practical, essays, short questions, or multiple choice questions (MCQs). The method used for assessment should be chosen

based upon an understanding of the limitations of each method of assessment and the relevance of performance to be measured. It must be comprehensive and the most effective method to measure learning or development should be employed. For example short answer questions are effective in assessing knowledge, whereas projects will measure formulation of problems better. It is not possible to pose all relevant questions in any one test, with the result that only sample questions are included.[35,49,67]

Feedback on assessment is imperative and should be rapidly available. It should enable the student to understand and construct meaning from the feedback. Students should be encouraged to interact with feedback to complete the feedback loop. Computer based assessment allows for instant feedback fulfilling the feedback needs of the students.[35]

Based on the assessment methods discussed it was decided to use MCQ tests for measuring achievement. The use of MCQs as method for assessment is regarded by some researchers as a method that should only be used to assess surface learning. Others regard it as a good tool to measure deep learning as well.[35] Even though there are still mixed opinions on the value of MCQs, Williams as cited by Robert[71] believes it can be used for the highest levels of evaluation. Williams recommended the use of MCQs for computer based informative assessment because of the ability to provide immediate feedback.[71] The use of the computer also removes the need for personal contact between the students and the assessor to prevent possible bias.[71]

The language needs for MCQs are similar to that of other methods of assessment as far as reading and comprehension are concerned. The expression of answers in a written format is however limited. MCQs may thus be to the advantage of students that are studying in a second language because they may find it difficult to express themselves in a second language.[35]

2.5.4 Development of an achievement test and experience survey

The researcher attended and successfully completed an Education Induction course as well as an Assessment of Student Learning in Higher Education course presented by the Department for Education Innovation of the University of Pretoria in 2004 and 2005 respectively. The knowledge gained during these courses was incorporated and combined with the principles and rules prescribed for the compilation of MCQ tests.

Rules of construct: Just like any other method of testing, careful consideration of the purpose and format of the questions are needed. The rules applicable to assessment remain valid when compiling any assessment including MCQ tests.[67,72]

Questions should be constructed in such a way that each question consists of two main components. The first component is the question or stem where the problem is posed. The second component consists of the options that are provided from which the student may choose. The options may include one or more than one correct answer. It is important to make sure that multiple correct choices are indicated when applicable to prevent confusion.[73]

Rules and techniques that will improve the construct validity of the test should be included in the planning and construction of the MCQ questions. These rules and techniques are as follows:

- Decide on the outcomes and level of knowledge that should be tested. If surface knowledge is required the questions may be short and to the point. If deep knowledge is required the questions should involve reasoning and insight.
- If questions are asked where blanks have to be completed they must be formulated in such a way that only one word will be correct. Spelling mistakes could prove to be problematic in questions of this nature.

- Language used in the questions should be the same as the language used in face to face sessions and other learning materials.
- Avoid negative statements in the questions, as they may cause confusion and result in inaccurate testing.
- Make sure that only one concept is asked at a time. Even when insight is required the correct option/s should be only applicable to the specific question.
- To increase the level of difficulty the options to choose from should include choices that are close to each other. In this way the choice is based on knowledge.
- There should be more than two options to choose from to reduce the possibility of random chance answers.
- Questions where two statements are to be matched may be set up in two columns. Here more options should preferably be included in the second column than that of the first column to reduce possible guessing by elimination.
- Hot spots where a label or element should be identified on a picture may be used.
- Visual material like short video clips may be used especially for questions based on application.
- The questions should not be suggestive of the answers.[73]

The achievement tests included all but the Summative type of assessment. Diagnostic assessment was present in the focus on specific outcomes. Performance assessment was done by the inclusion of applied questions that required integration of knowledge. Inovative assessment was present in the stimulation of self-learning presented in the repeated nature of the achievement tests. Formative assessment was the type of assessment used most and was the type of assessment used to identify the change in achievement.

The final measurement instrument required for the study was an instrument to measure the experience of the students.

To gather information on the experience of the students it was decided to make use of a survey. Even though surveys are used extensively for gathering information on various topics there are different opinions on the scientific value of the research results obtained by means of a survey.[74,75] There is however a strong belief in the validity of a well-constructed survey.[76]

In order to ensure a valid and reliable survey it is important to know exactly what it is that you want to know? The same rules and principles that are applicable for other assessments remain applicable to the questions included in a survey. Additional guidelines specific to surveys may be defined as follows:

- The questions must be formulated in a clear understandable way that will not confuse the respondent.
- Appropriate language must be used in short to the point questions that elicit useful information relevant to the subject surveyed.
- Statistical analysis of the responses should be possible.
- Identified facets should be addressed by the questions.
- Questions should not cause embarrassment or contain emotive words.
- Correct answers should not be implied in the question and should allow for opinions and values different to that of the researcher.
- No leading questions should be asked.
- Questions should be ethically correct.[75]

2.5.5 Criteria for validity and reliability

Both MCQs and surveys are methods of assessment consisting of questions that can be measured for validity and reliability according to similar criteria.

The criteria according to which this measurement could be done will now be discussed.

The criteria are as follows:

- Are the questions phrased appropriate to the answer?
- Are the questions valid for answering what needs to be known?
- Are the questions a true sample of the outcomes tested?
- Are the questions a reflection of the students understanding of the outcomes?
- Are the questions set in the language that the outcomes were taught in?
- Are some of the questions encouraging deeper learning?
- Is there any ambiguity in the intention of the questions?[35,77]

Validity: The types of validity that should be considered are content, concurrent and construct validity.[78,79] Each of these types of validity may be assessed according to the following questions and criteria.

Content validity: A positive answer to the following questions should be possible.

- Does the wording of the questions test the outcomes intended?
- Are the questions a true sample of the content tested?
- Are the questions valid for answering what needs to be known?
- Are the questions truthful?
- Are questions testing surface and deep learning? [79]

Concurrent validity: Concurrent validity provides predictability. If a concept is answered correctly in more than one way, the student should be able to answer questions on the same concept in the future.[80] Thus the same concept should be tested in more than one question in different ways to ensure concurrent validity.

Construct validity: Sub samples of the outcomes to represent the entirety should be used.[80] Questions that should be asked to establish construct validity may be:

- Are the questions fair?
- Are the questions a reflection of the students understanding of the outcomes?
- Is clear language used?
- Is there any ambiguity in the intention of the question?
- Are the questions phrased appropriate to the answer?
- Do the questions place anybody at a disadvantage?[35,67,75]

Reliability: The reliability of the MCQ test and experience survey depends on the ability to predict future values with the use of the same measurement instrument.[80] Large variations in the answers to a question could indicate a lack of consistency, precision, and dependability that may indicate construct or content problems and should be investigated.[67]

Reliability may be improved by adhering to the following basic principles:

- The questions should be clear and asked at the level of the students.
- The instructions should be simple and make a positive contribution to learning.
- The questions should be fair, comprehensive, and varied.
- Sufficient time to answer all the questions should be allowed.
- Sensitivity to gender, race, cultural background and abilities should be present.[67,68]

Adhering to these basic principles will increase the reliability of the instruments and result in good repeatability.[68]

2.6 Teaching the y-generation

Constant changes are taking place in the physical and social environment people grow up in. The physical and social environments are obviously influenced by changes in technology. Learning and teaching have to evolve according to the demands of the times. Research has brought better insight into the changing characteristics of children born in different generations. These characteristics result in different educational needs and interests of the students according to their social environment.[18] A summary, based on a table done by the Department for Education Innovation at the University of Pretoria and other sources, on the characteristics of the different generations and their needs is reflected in Table 2.2.

TABLE 2.2: Summary of typical characteristics and requirements of people that grew up in different eras[14,15,16,18]

Era	Name	Characteristics
1900 to 1946	Greatest Generation	They find it important to respect authority, have strong family bonds, be involved in the community, and have good self- discipline. They hate waste and the use of technology.
1946 to 1964	Baby Boomers	It is important to them to be responsible, have a strong work ethic with a Can-do attitude. They are defiant, pragmatic and individualistic. They hate laziness and turning 50
1965 to 1978	Latchkey generation	They find efficiency and fairness important, are good at multi-tasking, and they value their freedom. Their friends are more important than family, they are independent, and intrinsic motivators. They are sceptical of parents and believe in a work-life balance. They hate mediocrity; reject rules, red tape and hype.
1979 to 1995	Y-generation Millennial or Y-Generation	They find diversity, internet and multi-tasking important. Their parents and friends are important and they require structure. They are optimistic, realistic and have high expectations. They are team orientated. They hate institutions, anything slow, and negativity.

The first year occupational therapy students at the University of Pretoria that participated in this study were all born during the era identified as the y-generation (1979–1995).[15]

During this era there was and still is a fast rate of technological development that impacts on learning requirements. Students are highly mobile yet always connected, and technology forms an integral part of their lives. Cell phones, computers, i-pods, etc. are used extensively resulting in the students being able to piece together information from multiple sources, strengthening their intuitive visual communication enabling them to challenge educators who have not adapted to the new environment.[18] To keep pace with developments in technology,[81] and thus the students' methods of information exchange where technology is used, should be further investigated and developed.

In a study done by Thielfoldt[15] it was found that despite the extensive use of technology it is still important for these y-generation students to have face-to-face contact. Formal mentoring and structure are still required and these students respond well to personal attention. Educators are expected to facilitate learning with the use of e-learning, be passionate about their subject, and be able to maintain a balance between the use of technology and individual face-to-face teaching sessions.[15]

Educators involved in teaching the y-generation may be from the baby boomers, latchkey or y-generations as indicated in Table 2.2. They are thus not all equally comfortable and proficient with the technology that their students expect them to use.

Studies conducted by researchers like Ruiz et al[1] on the use of interactive learning found that the use of e-learning lightens the lecturing atmosphere because students are able to set their own goals. Material that requires interaction may be chosen according to the needs of the student. Slower students do not need to fear that they are keeping the other students back.

The more reserved students may do the self-testing included in e-learning without concerns that they may be regarded as slow students. Visual components add a real life dimension that assists in the understanding of basic principles of the subject. This is especially beneficial to the students with a more 'visual' proponent being part of their learning style. The user may revisit information as often as needed. A feeling of being in control of their learning, serving as motivation, is thus created.[82]

The results of the study by Ruiz et al[1], described the dependency of the y-generation on technology as well as the introduction of e-learning to be used as educational tool, has led to a more in depth look at e-learning.

The use of technology in teaching has resulted in the rapid evolvement of e-learning in educational circles. A good understanding of the methods of transmission of information is possible in e-learning and the advantages that could be gained for the students need to be understood.

2.7 E-Learning

Learning being an active process lends itself to interactive teaching.[83,84] E-learning in different formats is becoming more popular. It connects with the student's ability to access and interact with information directly on the net or with the use of an interactive programme based on specific content.

The use of e-learning may be synchronous or a-synchronous. Synchronous e-learning implies interactivity that takes place in real time.[66] For example the student and educator may be on-line at the same time in a real time discussion.

This study is concerned with a-synchronous e-learning where computer based information may be accessed at any time that suits the student and is not dependant on the availability of other individuals or the educator.[1] Computer

based interactive teaching may take place in chat rooms, black board programmes, computer based tests (CBTs), or other lone standing CDs and DVDs that allow active interaction with information. As technology develops more options will become available.

It is assumed that people born to the y-generation are all comfortable and keen to make use of computers and computer-based education. The truth of this assumption is still being investigated. Reeves et al[85] states that variations in the degree of acceptance of computer based education by the users are still observed. Gallew[17] concludes that evaluation of the effectiveness of e-learning for the student in the twenty first century is still not conclusively answered.

Early descriptions of studies done in 1980 by Taylor, as cited by Reeves et al, [85] on computer based interactive learning concluded that the computer could be regarded as a future replacement of the educator in the class situation. Other predictions made were that the use of computers will revolutionise teaching. In spite of these predictions the subsequent studies done on the use of computers for teaching found that computers are not always effective or well received. Reeves et al[85] concluded in 2000 that the disappointing results concerning the effective use of the computer as a learning resource were caused by the lack of proper instructional design. He used the guidelines described as the architecture of modern learning by Shank as cited in Reeves et al[85] for the development of e-learning. These guidelines will be discussed later in 2.10.

Occupational therapy students and e-learning:

Some studies on the effectiveness and acceptability of e-learning for occupational therapy students have been done by researchers like Cameron[24] and Davies et al.[21,] The results of these studies indicate some

elements that should be taken into consideration in the use of e-learning for occupational therapy students.

In 1998 Cameron[24] conducted a study in Australasia to determine the preparedness of occupational therapy students to use e-learning. This study concluded that the occupational therapy students that participated in the study showed resistance to using computer based learning. Even though the study was conducted with y-generation students their cultural and socio-economic background limited their exposure to technology. The relative unfamiliarity with computers could partly be the reason for the resistance to the use of computers in these Australasian students. Different aspects of their learning were studied to determine other possible reasons for the resistance to e-learning. It was concluded that e-learning could be implemented but that exposure to computers and a well-planned design should be implemented in such a manner as to stimulate the use of this medium effectively. The social and cultural background as well as previous exposure to technology of the students involved should be taken into consideration in the planning.

Another study done by Davies in Birmingham (United Kingdom)[21] with occupational therapy students of the Y-generation in 2005 indicated that effective learning took place with the use of e-learning. Even though these students were from a first world environment there were still some concerns from these students about computer based learning especially in the use of the computer based tests (CBTs).Davies et al[21] concluded that these concerns may be due to limited time provided for tasks and testing. The anxiety experienced by the students was associated with a lack of confidence in their computer literacy leading to negative experiences.

These studies by Cameron[24] and Davies et al[21] confirmed the need for careful planning and implementation of e-learning irrespective of the target group, to ensure that CDs will be optimally used in such a way that the students have a positive experience and that deep learning is stimulated.

Advancement of e-learning for occupational therapy students in the South African context and more specifically for the occupational therapy students studying at the University of Pretoria may very well be different to the findings of these studies. The diverse backgrounds of these occupational therapy students as discussed in 2.3 may impact on how they experience the use of e-learning.

With a better understanding of learning and the elements contributing to learning for the occupational therapy students of the y-generation it is time to consider the specific focus of this study. The focus of this study is teaching and learning Biomechanics. A closer look at the demands of the teaching and learning of this subject will be taken.

2.8 Teaching and learning Biomechanics

> *"Instruction begins when you, the teacher, learn from the student. Put yourself in his place so that you may understand what he learns and the way he understands it" (Kierkegaard cited by Felder et al)*[8]

Biomechanics is one of the study-units that are taught in the first year of studying occupational therapy at the University of Pretoria. Embedded knowledge of Physics at school as well as Anatomy taught from the start of the first year at University form the basis for Biomechanics.

By definition Biomechanics is "the study of the mechanical functioning of the human body in motion".[86] This implies that a good understanding of the basic principles and laws of mechanics should exist in order to be able to apply it to the human body.

The researcher has taught Biomechanics to the first year occupational therapy students studying at the University of Pretoria for the past ten years. A blended learning approach has been and is still being used.[1,18]

- Face-to-face sessions that provides 'visual' as well as 'verbal' instruction.
- Practical application sessions where 'active' kinaesthetic participation is required.
- Assignments where a 'global' problem has to be analysed and reflected in a 'sequential' manner,
- Class discussions where 'active', 'reflective', 'sensing' and 'intuative' participation is expected.
- Case studies where applied knowledge is explained 'verbally',
- Black-board use where 'verbal' information with the use of electronic media is made available. and
- Group work where interaction and 'reflection' with fellow students are all included.

In spite of the inclusion of all these methods already employed, a lack of comprehension of the basics and the more complex application of the knowledge is still observed in many students.

The lack of understanding may be attributed to the fact that the mechanical principles are often abstract in nature. The mechanical principles require 'sequential', 'reflective' and 'active' participation to gain true understanding. If this true understanding is not achieved the application of the principles is found to be challenging if not impossible. Lack of deep learning has a negative impact on motivation and the subsequent ability to assess and treat clients utilising principles learned.[87]

The outcomes of the course are planned in such a way that 'sequential' progression from basic knowledge to advanced application should be possible as described by Gidman.[4] To ensure that all the students are on the same level of knowledge; the basic mechanical principles are reviewed and then applied to inanimate objects. The movement of the human body is analysed according to its basic construct and movement patterns. Knowledge and principles are then combined and students are taught to analyse basic functions according to mechanical laws and principles. Initially surface learning to memorize definitions is employed. The use of 'reflection' and application of this surface learning then develop into deep learning.[32]

According to Kozma[88] there is an interaction between intellectual knowledge and knowledge of the world (experience). There is a difference in how novices (students) and experts (lecturers) learn. Students have limited knowledge that may lead to inaccurate interpretation of what they see. They only see objects whereas lecturers also see the biomechanical forces involved in the objects. The results of this difference in observation may explain why there is sometimes a gap between what the lecturer is trying to convey to the students and what they comprehend.

In order to assist in the recognition of the more complex nature of the knowledge, more graphic illustrations may be required.[87] The difference between a deeper understanding and reflection on the concepts being taught by the expert and the fact that there are still some students that struggle to grasp the application of basic principles, has led to the decision to explore the possibility of using interactive learning to supplement current teaching practices and to incorporate the advantages as indicated by Ruiz et al.[1]

Ernst et al[22] conducted a study to determine whether interactive teaching will improve the exam results of students with diverse science backgrounds. More interactivity was introduced in at least eight class sessions. Short quizzes were held with discussion on the possible answers until consensus was

reached. Visualisation and other audio-visual material were also introduced. Significant improvements on learning outcomes were found to be maintained due to deeper learning being stimulated.[22]

2.9 Development of an interactive CD as learning resource

Based on the information gained about the needs of the y-generation, e-learning, and the teaching and learning of Biomechanics, it was decided to develop an interactive CD for Biomechanics. The learning style profiles identified for occupational therapy students in Australia, Israel and Brooklyn[10,11,12], indicated that 'visual' and 'active' learning constitute some of the most commonly preferred learning style proponents.[10,11,12] The effectiveness of active learning was confirmed by the observations of the researcher as lecturer for Biomechanics.

The University of Pretoria like universities all over the world is striving to keep pace with technological development. In recognition of the need for e-learning by the students presently studying at this University, blended learning is strongly recommended.[2] Facilities and technical support at the University of Pretoria are available to lecturers for the development of e-learning in many formats including the development of a-synchronous CDs.

Considering the availability of computers on campus, and the seeming ease with which these computers and other e-learning tools are accessible to, and used by the y-generation students, it was assumed that first year occupational therapy students studying at the University of Pretoria will also prefer e-learning. In view of the findings of the studies discussed in 2.7 the assumption that these students will be comfortable using e-learning had to be proved. Based on this assumption being true the development of an interactive e-learning tool for teaching Biomechanics was initiated.

The aim of the CD was to provide a resource that would contribute to the learning and understanding of Biomechanics by the first year occupational therapy students studying at the University of Pretoria. It is important to remember that this CD was intended as a-synchronous e-learning resource to be used by the students in their own time. It needs to provide the students with a learning opportunity removed from the lecturer. It has to comply with the outcomes of the course and should stimulate a deep approach to learning. The identified 'active' and 'visual' proponents in occupational therapy students in other studies[10,11,12] emphasised the need to present these concepts in a more visual and interactive way. It was, however, also regarded as important to ensure that all the learning proponents of the students are accommodated as much as possible. The method in which the CD is used by the student will determine if e.g. 'reflection' is applied.

After discussion with other staff members in the Occupational Therapy Department, it was recognised that the practical application of Biomechanical principles remains relevant throughout the four years of study. Even though the knowledge of the more senior students matured, some students still struggled with some of the principles, especially in the application of these principles when treating clients. Qualified occupational therapists that came to hear about the project contacted the developer and enquired whether the CD could be made available to them when completed. The content was thus planned to include some of the needs of these more advanced students as well as qualified therapists.

Elements included in the planning were:

- Understanding of basic concepts
- Application of basic concepts
- Explanations of Terminology
- Choice of type and level of content to interact with
- Self-testing at the end of each section
- Immediate feedback to possible questions asked on the content

The computer based learning interactive resource should be student-centred and active interaction with the contents should be possible. Information should be presented in such a way that the attention of students with different learning styles may be captured in the most effective way.[89]

Guidelines described by Shank as cited by Reeves et al[90] on the methods of learning that should be included in e-learning tools were studied. The following methods of learning were taken into consideration in the planning of the interactive resource:

- Simulation-based learning: Learning by doing.
- Incidental learning: Gaining knowledge that could inherently be regarded as boring but ending with interesting results.
- Learning by reflection: Reflecting on a problem to figure it out.
- Case-based learning: Learning by experience whilst being told what needs to be known.
- Learning by exploring: Generating questions while exposed to new knowledge. [89]

Another aspect that needed to be considered was which elements to include encouraging the student to use the CD. Elements such as decision making, application, and self-testing were included in order to enrich the learning experience.[50,58] A positive and challenging learning experience influences the attitude of the student to stimulate a deeper understanding of the content being learned.

The ease of use of the resource is important. It will influence the experience of the user if it is easy to navigate and to find information. Guidelines such as these greatly enhanced the quality of the CD.

One of the advantages of an interactive CD over that of printed media is the future updating of the CD that will be possible with the assistance of the technical design staff.[89]

Extensive planning was done before the project could commence. The content of the CD was planned according to the outcomes taught in class. Basic principles of mechanics on inanimate objects were included first. The application of the basic concepts was then described and illustrated. Analysis of the individual muscles and body functions were followed by more in depth applications. Finally the application of biomechanical principles in real life and therapy situations were demonstrated. Activities and objects that may be used during everyday life or during treatment were presented. After each chapter questions and answers were included to allow for self-testing. These self-testing quizzes included all types of assessment described by Bloom's taxonomy except Summative and Formative assessment. The students may choose to use the quiz as Baseline assessment before they interact with the content of the appropriate chapter of the CD. Diagnostic assessment may flow from the assessment indicating areas where knowledge should be expanded on. Because the quiz is totally optional the student my use this assessment as Innovative assessment to identify self-learn opportunities.

With the assistance of the Department of Education Innovation the programming, animations, video recordings, photography and graphic art needs analysis were done and a plan of action was decided upon. A formal application containing motivation, plan, and costing was submitted. Approval was obtained from the Department of Education Innovation for the funding of the development of the interactive 'Basic Biomechanics for therapists' CD.

The software used for programming had to allow for:

- Easy interactivity with text, terms, videos, photos, animations, and sketches.
- Navigation to any chosen part of the information
- Drag and drop actions

- The ability to do multiple choice questions for self-testing with immediate feedback

Two different software programmes were used to accommodate all the interactive needs of the CD. Completed CD available in Appendix B

2.10 Summary

The literature review undertaken for this research includes research done in the first world as well as developing nations. Researchers from different fields of practice seem to agree that learning patterns develop from birth and continue developing throughout one's life. These learning patterns develop through interaction between the child and its environment, and grow into learning habits. These learning habits form the basis for adult learning. There are different elements that may impact on the success of learning. Some of these elements are the inherent intellectual (cognitive) ability, learning style of an individual, as well as various environmental elements.

When students commence with tertiary education, learning becomes more self-driven. It is regarded as a means to an end and adult students want to control this learning process for themselves. Students need to learn how to adapt learning methods to their own learning style to optimise learning.

The occupational therapy students included in this study form part of the y-generation. Technology plays an important role in the requirements of the y-generation for transmission of information. The incorporation of technological development should be considered in the methods of teaching to accommodate the needs and interests of the students but should not be regarded as a replacement of face-to face teaching. Students from developing nations may be less comfortable with the use of computers and may thus be less open to the use of multimedia learning resources as was

found in the study done with students from Australasia. A careful balance should be maintained to keep the students stimulated and interested in order to achieve better results and deeper learning. E-learning could be included in teaching but it should be reassessed regularly to ensure that the changing needs of the students are met.

Determining the learning style profile of a group will further assist the educator in the planning of the methods of teaching to be employed. The teaching methods should include elements of all the different learning styles with more emphasis on the most representative learning profiles of the students in a particular group. The learning styles of occupational therapy students were identified by different studies. The learning style proponent most often identified for these students is 'active' learning.

Based on the information gathered on the needs of the students and the advantages of e-learning, an a-synchronous interactive CD was developed. The development of this resource had to be carefully planned according to the requirements of the target group and the content that was included in the resource. Differing competencies of the sample group required that learning could be done in their own time making the use of a-synchronous e-learning well suited. Innovative assessment was used in the resource to allow the users to conduct self-testing with the purpose of expanding and evaluating their understanding of the content.

Keeping up with the changing needs of the students is important. If students are sufficiently stimulated they will maintain their motivation to study and become competent therapists that are able to maintain a lifelong habit of deep learning.

Available academic research relevant to the study makes it possible to conduct further research from a firm base. What needs to be done is to determine the applicability to the South African sample group at the

University of Pretoria. In the absence of similar studies for the target group assumptions could be made based on the existing research.

CHAPTER 3

RESEARCH METHOD

3.1 Introduction

Owing to the fast developing technology that students are exposed to the demand for interactive multimedia as a teaching medium is increasing.[17] In spite of this demand, literature indicated different opinions on the acceptability of such a resource for occupational therapy students. However no information on how effective and acceptable this medium is for occupational therapy students in South Africa could be found.[13]

As described in 2.10 an interactive CD '*Basic Biomechanics for therapists'* was developed by the researcher for the occupational therapy students studying Biomechanics at the University of Pretoria. This interactive CD presented an opportunity to study the effect of e-learning on these occupational therapy students. The question asked was: Will the interactive '*Basic Biomechanics for therapists'* CD have an effect on the achievement of the students and, will it be utilised?

A quantitative study consisting of four objectives was conducted. The method used for this study will be discussed in this chapter. The study was divided into three phases. The design for each objective was chosen to accommodate the type of data that were gathered to be analysed.

Due to the need to develop measurement instruments a pilot study had to be conducted as part of the research process. The methods, process and

analyses of this pilot study will be discussed as part of the measurement instruments.

This Chapter will describe the methods used to conduct the research under the following headings.

- Process and design of the study
- Research sample
- Measurement instruments
- The Study
    - Validity and reliability of the study
    - Data collection and recording
    - Data analysis
    - Ethical considerations

3.2 Design and Process of the study

3.2.1 Design of the study

A Quantitative approach was used to conduct the study. The first three objectives required data capturing. Each one of these objectives required different methods of data capturing according to the nature of the data. Analyses of the data gathered were then conducted according to the type of data obtained.

No new data were required for Objective 4 because the data captured for the first two objectives were combined for further analyses to address this objective.

3.2.2 Research process

Before the study could commence a pilot study was conducted. The same process as described for the study was followed in the pilot study.

The study was divided into three phases. Each phase focused on specific objectives as identified previously in 1.4.2. The process followed during the study is illustrated in Fig 3.1.

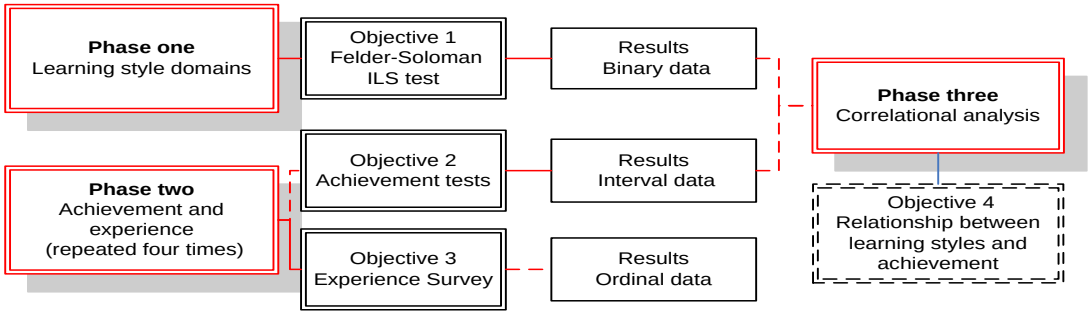

FIGURE 3.1: A diagrammatical illustration of the process followed for the research

The study was divided into three phases and will be described according to the sequence indicated in Fig 3.1. Data capturing and analyses for Phases One and Two had to be completed before Phase Three could be done.

Phase One: Objective 1: Objective 1 was addressed in this phase. The purpose of Objective 1 was to determine the learning-styles of the participants. A cross-sectional, descriptive design was used.[91] Learning-styles were determined with the use of the Felder-Soloman-ILS instrument that provided binary data in the form of dichotomous answers to the questions.[79] The binary nominal data was converted into numerical indices for statistical analysis.

Phase Two: Objectives 2 and 3 formed part of phase two. Each objective will be discussed separately.

Objective 2: Objective 2 was aimed at determining the change in learning, measured as achievement, of the participants. A cross sectional design with a nonrandomised group pre-test–intervention- post-test with a repeated measure timeline was used.[92] Achievement was tested in four evenly spaced separate sessions during which continuous interval data were gathered. The repeated measure was used in order to accommodate different outcomes and to allow each participant to be measured at different times.

Hypotheses were stated for this objective:

Null hypothesis: The interactive *'Basic Biomechanics for therapists'* CD has no effect on the achievement of the first year occupational therapy students studying Biomechanics at the University of Pretoria.

Alternative hypothesis: The interactive *'Basic Biomechanics for therapists'* CD has an effect on the achievement of the first year occupational therapy students studying Biomechanics at the University of Pretoria.

Objective 3: Objective 3 was to assess the experience of the students when using the interactive *'Basic Biomechanics for therapists'* CD. A cross sectional repeated measure descriptive design was used.[91] Ordinal data was gathered with the use of a survey. This ordinal data was collapsed into binary data to indicate only a positive or negative value for each question to indicate satisfaction or dissatisfaction. The data were thus analysed as nominal data.

Phase three: Objective 4: Objective 4 was aimed at determining a possible relationship between the learning style proponents of the participants (Objective 1) and the achievement (Objective 2) of the participants.[93,94] A correlational design was used.

3.3 Measurement instruments

The measurement instruments to be used for the study were selected and developed by the researcher. The first measurement instrument was the Felder-Soloman Index of Learning Styles (ILS) test. This test was developed for engineering students and has only been used in one study with occupational therapy students.[66] The four achievement tests and experience survey had to be designed by the researcher.

In order to confirm the suitability of the Felder-Soloman ILS for the sample group a pilot study was conducted in 2009. The pilot study was also used to establish the validity and reliability of the achievement tests and experience survey for use in this study. The pilot study was done accrding to the same design and method as the research study. Observational methods were used to gather additional information during the process.

3.3.1 Pilot study

A pilot study was conducted at the beginning of the second semester in 2009. First year occupational therapy students studying at the University of Pretoria in 2009 were asked to participate in this pilot study. These students formed a convenient sample that was limited to a cohesive group studying the same subject in the same programme.[79,91]

The primary purpose of the pilot study being the evaluation of the possible validity and reliability of the achievement and experience survey measurement instruments. The secondary purpose was to establish the time needed for the completion of each of the three measuring instruments for data collection purposes.

The purpose and the procedure of the pilot study were verbally explained to the students. Assurance was given that participation in the pilot study would have no effect on their marks for the study unit. It was explained that the achievement test and intervention resource formed part of the curriculum and should add to their understanding of the outcomes. Voluntary verbal consent to participate was obtained. Written consent to publish the results of the analysis of the data was obtained at a later stage as available in Appendix E. A total of 37 students agreed to participate in the pilot study.

Objective one: The Felder-Soloman ILS test was completed during class time. The students were excited to participate in a test that would provide them with information about themselves that may assist them in their studies. The Felder-Soloman ILS test was done on paper and submitted by the researcher to the internet for interpretation. The time needed to complete the test was noted. The results of the tests were made available to the students with information on the interpretation of the results as available in Appendix F. The interpretation of the results included suggestions on how they may adapt their learning methods to gain the most from classes taught according to a combination of different styles.

The following observations were noted.

Observations:

- The time needed for all the students to complete the learning styles test was twenty minutes.
- In a discussion after completion of the test the students indicated that the test questions were easy to understand.
- When the results and interpretations of the learning styles test were made available to the students they indicated that the test results were perceived as accurate according to how they perceived their own methods of learning and teaching preferences.

Indications from the student feedback after the pilot test were thus positive, confirming that the Felder ILS instrument was found to be user friendly and an accurate reflection of their learning-styles.

Objective two: No measurement instruments suitable to measure the achievement as required by the study were available. A suitable measurement instrument needed to be developed by the researcher. The computer based nature of the interactive *'Basic Biomechanics for therapists'* CD determined that the measurement instrument should also be computer based. The achievement test was based on the outcomes covered in the two preceding face-to-face sessions. Time constraints limited the number of outcomes that could be tested.[95] Only one baseline pre- and post-achievement test was set for the pilot study.

The contents of the achievement tests complied with the outcomes of the Biomechanics taught in the first year of studying occupational therapy at the University of Pretoria. Each test consisted of 30 questions. These 30 questions were set according to the following guidelines:

- Questions were divided into groups according to the outcomes tested.
- Questions were asked on the same level that would be expected of students in a formative or summative test.
- Questions for each outcome included basic knowledge, comprehension, and insight with more than one question testing the same outcomes.
- Variations in the questions were small enough not to require totally new knowledge that would have impacted on the test scores.[74]

The programme used by the University of Pretoria for computer based tests is the Umfundi® programme. The programme allows for randomisation of questions as required. Randomised selection of 20 out of the possible 30 questions was implemented to reduce the likelihood of exactly the same

questions being asked in the same sequence for any two participants or in any two consecutive tests.

A quality control check of the achievement test was done by the education committee of the Occupational Therapy Department. A copy of the achievement test that was set for the pilot study is available in Appendix G.

The observational method was used during the data capturing session to note the behaviour of the group.[77,78] The general behaviour and reactions of the students were observed to identify possible problems with the process. They were asked to indicate any problems experienced by calling the researcher or the laboratory assistant.

Each participant was required to complete the 20 randomly selected questions. The time it took for all the students to complete the pre-achievement test was noted. Total marks scored for the test was available on completion of the pre-achievement test. No indication on which questions were answered incorrectly was provided.

After completion of the pre-achievement test the students were given access to the appropriate section of the interactive '*Basic Biomechanics for therapists*' CD. The students were asked to indicate when they felt that sufficient time was allowed to study the learning resource by raising their hands.

After all the students finished studying the appropriate content in the interactive '*Basic Biomechanics for therapists*' CD a five minute break was given. The achievement test was repeated as a post-test. Once again 20 randomly asked questions were answered. Time to complete all the questions was not limited.

Observations:

- The pre achievement test: Ten minutes.
- CD (intervention): Forty minutes.
- Break: Five minutes
- Post achievement test: Ten minutes

Based on the results of the pilot study some changes were made to the baseline achievement test and three more tests could be designed according to the requirements of the outcomes.

Objective three: To assist the researcher in the compilation of the questions for the survey the structure of a well-researched example survey (unpublished as yet) developed by Wolfaart[96] was used as guide. This survey by Wolfaart was developed for gathering data from students studying medicine at the University of Pretoria.

Specific outcomes were identified for the survey. The outcomes regarded as the most prominent for most effective use of the intervention tool were identified. These outcomes had to be covered by the questions posed in the survey. It is good practice to have more than one question asked in different ways to address the same outcome. Ten closed questions were developed available in Appendix H.

The number of questions included in the survey related to each of the identified outcomes is indicated in brackets. The outcomes were as follows:

- Computer literacy.(3 questions)
- Level of understanding (3 questions)
- Type of learning (2 questions)
- Control over learning (1 question)
- Self-testing (1 question)

The survey questions were also programmed according to the Umfundi® programme to make completion and scoring of the survey by computer possible. No randomisation of questions was needed.

Measurement was done by dividing the responses into categories according to the response as illustrated in Table 3.2. Numerical values to demarcate the categories were allocated and could thus be measured as discreet data. Care had to be taken in the allocation of these values to ensure that they provide a true reflection of the opinion of the respondents.

TABLE 3.2: Scale used for scoring the experience survey

1: Strongly disagree
2: Disagree
3: Neutral
4: Agree
5: Strongly agree

A Likert scale was used to record the ordinal data for the survey. Care had to be taken that the values were equal to each other to avoid a measurement error before the survey was even started.[77] The scale was then collapsed to reflect only positive or negative responses. Questions and responses were reduced so that the number of variables that had to be analysed for possible relationships could be limited. The results were thus collapsed into binary data that resulted in a nominal scale being used for statistical analysis.[77]

Students were allowed to leave the venue as soon as they completed the survey. Once again the time for all the students to complete the survey was noted. The experience survey was completed in five minutes.

Statistical analysis of the data obtained from the pilot study: Each instrument had to be analysed according to the type of data gathered. The first analysis done was that of the Felder-Soloman ILS test.

Index of Learning Styles test**:** The ordinal data obtained for the Felder-Soloman ILS test during the pilot study was analysed and a baseline learning style profile for occupational therapy students studying at the University of Pretoria was established. The analysis process and results will now be discussed.

The dichotomous data was grouped according to the proponents represented by each question. The first analysis that was performed was a simple frequency distribution between the two proponents of each domain. Each person's learning style profile consists of all four domains with only one proponent dominant for each domain. The proponents are reflected as opposites on a linear scale and are reflected as positive or negative values. The proponents that are identified as positive values are reflected in the first column with the proponents identified as negative values in column four. Each row represents a domain with the two representative proponents.

The responses to each proponent were included without any regard to the weight value indicated for each question. The results are reflected in a simple frequency distribution table.[94,97] The 'active', 'sensing', 'visual' and 'sequential' were the four proponents that define the learning style profile for the group. See Table 3.3.

TABLE 3.3: Relative scores by domain with N 33

Proponent	N	%	Proponent	N	%	Total
'active'	22	66.7%	'reflective'	11	33.3%	33
'sensing'	26	78.8%	Intuitive	7	21.2%	33
'visual'	28	84.8%	'verbal'	5	15.2%	33
'sequential'	22	66.7%	'global'	11	33.3%	33

A multi-joint correspondence analysis was performed to determine what the relative distribution of the learning style proponents' are.[98] The results of this correspondence analysis are reflected on two dimensions. See fig 3.2.

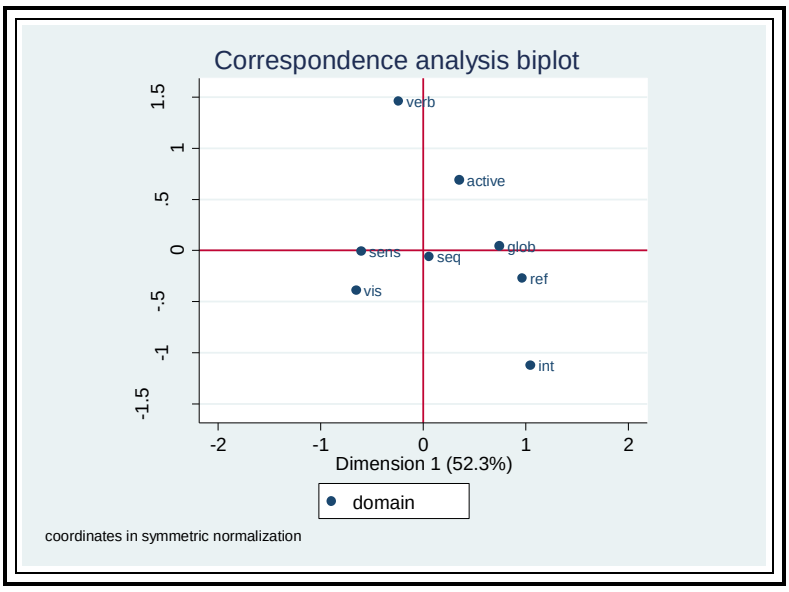

FIGURE 3.2: Distributions of the learning style domains key:'verbal' – verb, 'visual' – vis, intuitive – int, 'sensing' –sens, ''global'' – glo, 'sequential' – seq, 'active' – 'active', ''reflective'' – ref

The relative distribution of dimension one represents 52% and dimension two 25% of the group. The 'sensing', 'global', 'sequential', 'visual' and 'reflective' proponents are lying close together and may be regarded as a cluster. The

'verbal' and 'intuitive' proponents are far removed from the other proponents showing no association with the other proponents. The 'active' proponent is situated between the cluster and the 'verbal' proponent also standing more on its own with no association with the other proponents.

This depiction of the relative distribution of the learning style proponents in a bi-plot make it easy to identify possible similarity to the distribution of the learning styles to that of other year groups.

Pre-and post-achievement tests**:** The data for the achievement tests was collected as interval data.[92] The results of the pre-and post-achievement tests were compared in a paired t-test to determine if the intervention made a difference in the achievement of the students. An assumption that the difference between the pre-achievements test and post achievement test would be zero was tested requiring t>0.05 to indicate significance. The degree of freedom was N32 with a 95% confidence interval. The results are available in Table 3.4.

TABLE 3.4 A comparison between the mean scores of the pre-and post-achievement tests with N 33

Variable	N Observed	Mean	Std. Deviation	95% Conf. Interval]
pre-test score	33	75.15	7.80	72.39-77.92
post-test score	33	81.67	7.34	79.06-84.27
difference	33	6.52	10.99	2.62-10.41

A significant change between the two tests was found with a t-test score of t= 0.0001 with a mean difference of 6.52.

A box and whisker diagram based on the mean scores of the pre- and post-achievement test scores using the upper and lower quartile points reflected

the variability and distribution of the data. Only one outlier as could be seen in Figure 3.3 was indicated in the post-test.[98]

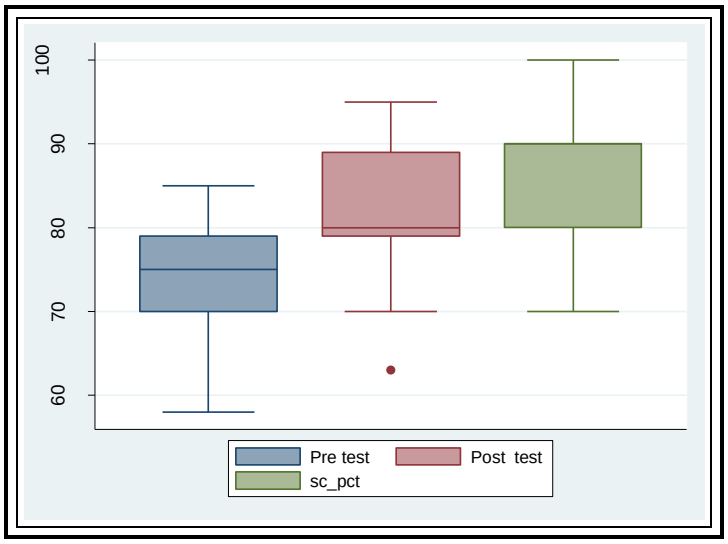

FIGURE 3.3 Pictorial representation of the pre-and post –achievement test results

Experience survey: The ordinal data gathered for the experience survey was recorded according to a Likert scale as illustrated in Table 3.1. One of the elements that had to be considered was what should be done with neutral or missing answers. The answers were recoded according to the commonly used negative value where 1, 2 and 3 were regarded as negative or 0 codes. The remaining two values (4 and 5) represented the positive or 1 values.[97] The converted dichotomous data obtained in this manner could then be analysed as nominal data. See Table 3.5.

TABLE 3.5 A frequency table reflecting the responses to the survey questions

Question	Value	Frequency	Percentage
1	0	0	0
	1	33	100
2	0	1	3.03
	1	32	96.97
3	0	7	21.21
	1	26	78.79
4	0	1	3.03
	1	32	96.97
5	0	17	51.52
	1	16	48.48
6	0	0	0
	1	33	100
7	0	2	6.06
	1	31	93.94
8	0	1	3.03
	1	32	96.97
9	0	6	18.18
	1	27	81.82
10	0	14	42.42
	1	19	57.58

The results indicated that questions five and ten resulted in inconclusive answers. Question five was based on a choice between 'visual' and 'verbal' learning style preferences. Question ten was the only direct indicator on the attitude towards using a computer based learning resource.

3.3.2 Validity and reliability of the measurement instruments

Validity: The achievement tests and experience survey were studied according to the guidelines and rules as described in 2.6 [76] Specific attention was paid to the following:

Concurrent validity: The short time lapse between the pre- and post-tests assisted in the confirmation of the concurrent nature of the results.[95] The statistical analysis of these results confirmed concurrent validity of the tests. The results of 33 participants were analysed according to a comparative method. A significant difference was indicated between the pre and post achievement tests with a one sample t test value of t = 0.001. The significance was limited by the number of students.

Construct validity: The pilot study was performed early in the curriculum so the questions were mainly focused on knowledge with limited application thus requiring mostly surface learning to be in place with limited expected deeper learning expected. The questions were limited to outcomes covered in the face-to-face sessions prior to the test.

Construct validity of the achievement test and the experience survey was tested by the use of peer assessment and the education committee of the Occupational Therapy Department. The statistical results of the pilot study confirmed the face and construct validity.

Internal validity: Internal validity was achieved by ensuring that the achievement of participants was measured before and after the intervention. The variables as identified for the study and the controls thereof will be discussed in more detail in 3.4.3 External variables were minimised by the fact that no comparison to other students was done. There was no bias present in the selection process because all the first year occupational therapy students in 2009 participated in the pilot test.[77]

In the statistical analysis a one sample t-test was done to determine the validity of the change between the pre- and post-achievement-tests. A statistical score obtained with a degree of freedom of 32 indicated significance as illustrated in Table 3.6. A table value of t>0 indicates a significance. The score was t=3.4 indicating good validity.

TABLE 3.6: A one sample t-test using the difference between the pre- and post-achievement tests with N33

Variable	Observations	Mean	Std. Deviation	[95% Conf. Interval]
dif1	33	6.52	10.99	2.62 10.41

Face validity: Face validity was evaluated through peer assessment and the feedback from the students participating in the pilot study. A feedback session with the students was held in class after the pilot study.

The information supplied by the students during discussion after the pilot study included the following:

- The students indicated that the session contributed positively to their understanding of the concepts tested.
- The achievement tests helped them identify gaps in their knowledge and understanding.
- The students that had a low score for the first achievement test indicated that they realised that they will have to put in more effort to understand the content. They were encouraged when they achieved a better score in the second achievement test.
- The students that achieved good marks in the first achievement test had mixed reactions to their motivation in studying the CD. Some

wanted to improve their score and others felt that they understood the outcomes already and were not motivated to study the CD.

Questions and answers in the discussion after the pilot study included the following:

Q: What aspects of the outcomes do you think the test assessed?

A: Forces, application of forces, levers, and the application of levers

Q: Do you think that the questions tested your knowledge?

A: The majority agreed that their knowledge was tested.

Q: Do you think all the outcomes covered in the face-to-face sessions were covered to the same extent?

A: There were mixed reactions to this question but the consensus was that more questions were asked on some outcomes than others.

Q: Did you find some questions more challenging than others?

A: Majority yes.

Q: Did the availability of the information tested directly after the test assists you in your understanding of the work?

A: Majority yes.

These results confirmed that the questions were at the correct level but that some changes had to be made to the distribution of the questions. To improve the face validity of the achievement tests more, the questions had to be more inclusive of all the outcomes.

Reliability: Reliability was established with the use of comparative statistical analysis. Scores achieved by the students were indicated on a graph according to the difference from zero. Eight of the comparisons between the pre-and post-achievement test scores were found to be less than zero as

depicted in Figure 3.4. This indicated that there was improvement in 75% of the group.

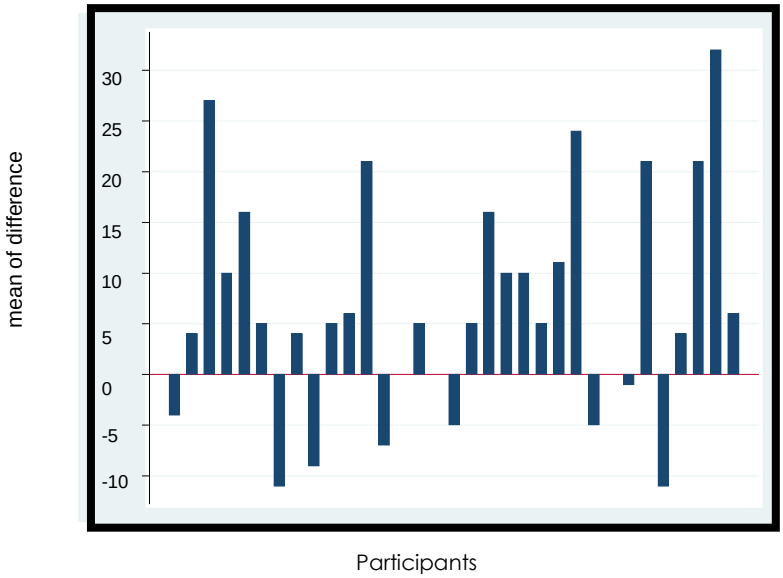

FIGURE 3.4: Average change between the pre- and post-achievement scores for each student indicated in a bar chart

The results indicate a change between pre- and post-achievement tests significantly different from zero with a probability of 3.4. The question that one might wish to ask will be "is the change clinically significant?"[95] The clinical significance had to be tested in the research study with a bigger sample group and repeated testing and will be discussed in 5.2.2.

Good repeatability was indicated by the results. It confirmed that the objective to establish the reliability has been achieved.

The results indicated a good validity and reliability for both these measurement instruments. It should however be remembered that the sample group was small at N33 which left room for possible errors.

3.4 The study

3.4.1 Implementation of the results of the pilot study

The analyses of the pilot study data were used as guidelines for the formulation of the measurement instruments to be used in the research study. The first instruments that had to be further developed were the four achievement tests.

Achievement tests: A repeated measure method was to be used during the research study for the achievement test. The possible effects that internal and external variables may have had on the results of the study were reduced by this repetitive measure.[91,99] At the conclusion of the pilot study the four tests were set according to the same criteria discussed in the development of the achievement test for the pilot study in 2.5.4 The results of the pilot study were used to identify possible changes.

Each achievement test had to be compiled according to the outcomes covered in face-to-face sessions prior to each testing. The progression of the outcomes of the course was such that maturation of knowledge had to take place. Different areas of knowledge had to be mastered, integrated, and ultimately applied. Each outcome covered for each period had to be tested by more than one question in each test.[74] Assessment of the participant's knowledge and a better understanding of the outcomes could thus be included in the assessment.

In the development of the four achievement tests for the study, the questions had to be divided into four or five topics based on the outcomes taught in the preceding face-to-face sessions. Each topic had to include basic-knowledge and insight in the form of applied questions ensuring a balance in the requirements of each test as well as concurrent validity.[74,95] Concurrent-validity was also included in the progression of the tests in the maturation in

knowledge requirements.[95] The final test required the most integration of the subject outcomes. The four tests developed for the study are available in Appendices I-L.

The randomisation of the questions with the use of the Umfund® program further contributed to the equal distribution of questions for each topic and outcome. The procedure is illustrated in Table 3.7.

TABLE 3.7: An illustration on the procedure used by the umfundi® programme to ensure equal representation of the content tested

Concept	Category	Questions	Random questions asked in pre-test	Random questions asked in post-test
Forces	Basic knowledge	1		1
		2	2	
		3	3	3
	Comprehension and insight	1	1	1
		2		2
		3	3	

Experience survey: During a discussion after the session the following questions were asked:

Q; Did you mind being asked these questions?

A: Majority no. The questions were regarded to be representative to what they experienced.

Q: Did the questions asked allow you to express your experience in using the learning resource sufficiently?

A: Some agreed that the questions allowed them to express themselves others would have liked an open question for own comments as well.

Q: Were the questions relevant to what you found in the learning resource?

A: Majority yes.

No changes were made to the experience survey. The need to allow own comments was not included because this addition would have resulted in the addition of qualitative data that the study did not make provision for. The inconclusive questions five and ten were kept the same because they provided valuable information on attitude and possible learning style related preferences.

After completion of the pilot study the research study could be conducted as determined by the results of the pilot and according to the process and design as discussed in 3.2.

Index of Learning Styles test: (Objective 1) The Felder and Soloman ILS test was completed on the intranet of the University of Pretoria. Results were resubmitted for interpretation as will be described in 4.3

Achievement Tests: (Objective 2) Four achievement tests were developed as measurement instruments for the study. Each test consisted of 30 questions of which 20 had to be answered. The outcomes tested in each test were based on outcomes according to the curriculum covered in the preceding two face-to-face sessions as indicated in Table 3.7. Each of the four tests was available in English and Afrikaans as can be seen in Appendices I-L. Scoring was done by computer.

Experience Survey: (Objective 3) The survey developed for the pilot study remained the same as measurement instrument to measure the experience of the participants when using the CD. The same experience survey as available in Appendix I was repeated after each of the four data capturing sessions. Scoring was done electronically.

3.4.2 Research Sample

Population: The study was aimed at the theoretical total population of occupational therapy students studying Biomechanics at the University of Pretoria in 2010 and 2011. Biomechanics is taught in the first year thus the sample group consisted of first year occupational therapy students.

Sampling method: A convenient sampling method as propagated by Polit et al[91] was used. All the first year students selected to study occupational therapy at the University of Pretoria during 2010 and 2011 were invited to take part in the study. No exclusions were imposed.

The introduction to the study was done shortly after classes commenced in the first semester of 2010 and 2011. A class session was scheduled in the computer laboratory. A predetermined range of four digit numbers printed on slips of paper were placed in a box. Upon entering the venue each student was issued with an information leaflet and consent form, as available in Appendix M. A number was randomly picked from a box. The number was recorded and acknowledgement of receipt of the information leaflet was signed by the students on a class list.

Time to read the information leaflet was allowed before a verbal explanation of the purpose and procedure of the study was given. It was emphasised that participation was voluntary and that there would be no consequences for non-participation. The consent forms were completed and collected by a staff member other than the researcher.

Sample size: Due to the limited number of occupational therapy students selected per year, the study was conducted over two years to ensure a large enough sample size. Wangcharoen, Ngarmsak and Wilkinson as cited by Petersen[100], a minimum sample size for data collected according to different scales may vary. The sample sizes where noticeable change may be measured are as follows:

- Nominal: 8-24 participants
- Interval: 8-32 participants
- Ordinal: 8-40 participants[100]

The number of students present at the first data collection session and the number of students that completed consent forms to participate in the study determined the sample size. Students that were absent during the first session were not included as participants in the study due to technical difficulties to repeat the first data capturing session. The sample size according to each year group that formed part of the total sample is illustrated in Table 3.1.

TABLE 3.1: Sample size per year group for 2010 and 2011

Year group	Students enrolled	Students present	Students absent	Completed consent
2010	46	39	7	39
2011	45	42	3	42
Total	91	81	10	81

3.4.3 Validity and Reliability of the study

Before data collection could commence the variables associated with the validity and reliability of the study had to be identified. The internal (personal) and external (environment) confounding variables as well as other variables that may have an impact on the study had to be considered. Identification of these variables made it possible to put control measures in place where possible. By controlling the variables the significance of the results of the study was increased and the possible repeatability of the study was improved.[101]

The following elements related to the validity and reliability of the study will be discussed:

- Independent and dependant variables
- Confounding variables affecting the internal and external validity of the study
- Reliability of the study

Independent and dependant variables: Control of the independent variables was important to ensure that the results obtained from the data were not influenced by the confounding variables. These variables could have confounded the testing of the hypotheses and thus made the data unreliable.[94]

Independent variables: The independent variable identified for this study was the variable that may have affected the dependant variables namely the learning and experience of the participants.[98] The independent variable identified for this study was the exposure to the interactive '*Basic Biomechanics for therapists*' CD. The contents studied were the same for each participant but it may have been interpreted differently according to the individual learning-style affecting the effectiveness of the learning and thus the experience of using it.

Dependent variables: As mentioned the dependant variables for this study were the learning styles, the learning measured as achievement and the experience of the participants using the interactive '*Basic Biomechanics for therapists*' CD. These variables were the result or measured outcome of the actions of the independent variables.[79]

Confounding variables affecting the internal and external validity of the study: The internal validity of the study depended on the controls that were put in place for the confounding variables. In order to put these controls in place the internal and external variables were identified.

Internal variables: The identified variables that could possibly influence the internal validity of the study were; selection, maturation, mortality, personal abilities, language, and the effect of bias. Control measures that were put in place where applicable will be discussed.

Selection: No exclusions were imposed. All first year students selected to study occupational therapy at the University of Pretoria were invited to participate in the study.

Maturation: The natural progression of the outcomes of the subject Biomechanics are of such a nature that maturation is expected.[4] The individual maturation that took place was not measured against other participants; therefore, the maturation reflected in the study results did not reduce the validity.

Mortality: Mortality was anticipated as a natural part of the study. In 2010 only one student changed to a different course at the end of the academic year after data capturing was completed. Data could still be used it thus did not impact on the sample size.

In 2011 no students left or changed course during the academic year. Absenteeism was experienced but due to the repetitive measure, the results of the study were not adversely affected.

Personal abilities: The performance of the participants may have been influenced by fatigue, being ill, or other personal factors. The repeated measure design of the study allowed for a more balanced measurement of participants' abilities and achievements.[94]

Pre-knowledge: All participants were assessed according to their individual embedded knowledge based on the modules taught at school and newly acquired knowledge obtained in the first semester. Further newly knowledge was obtained during the face-to-face sessions preceding each data capturing session for Phase Two. Individual achievement and experience was

not compared to other students, only to themselves. The absence of comparison to other participants negated the possible negative effect that pre- knowledge could have had.

Language: The language policy at the University of Pretoria is that all test and exam materials should be available in both Afrikaans and English. The achievement tests for the data capturing sessions were set according to this policy in both languages. English is regarded as the official language at the University of Pretoria therefor the *interactive 'Basic Biomechanics for therapists'* CD, experience survey and all the face-to-face sessions were only presented in English.

Bias: Because the researcher was also the presenter of the course and thus got to know the participants personally, bias could have been present. Bias was controlled by strictly managing the data according to the random four digit numbers. The use of these numbers protected the anonymity of the participants during the study. Computerized scoring further reduced bias that may have influenced the results of the tests.

Preceding activities: Activities that the participants were involved in before the data capturing session may have resulted in a systematic error.[93] Some of the sessions were done directly after fieldwork that required a lot of energy and concentration from the participants. This fieldwork may have resulted in a lack of motivation to attend the afternoon session and a reduced level of concentration. Lower scores may have been possible in the achievement tests, especially in the post-achievement test due to exhaustion. Due to the structuring of the classes it was not possible to change the time available for these data capturing sessions.

External variables: The external variables that were identified were of such a nature that they could mostly be controlled by the structuring of the research process. The possibility that data were negatively affected was therefore less likely.[94]

External elements that could possibly influence the validity of the study were; exposure, place, availability of the scores, and time.[91]

Exposure: All the participants were exposed to the same face-to-face sessions based on the outcomes to be tested prior to each data capturing session. The researcher had no control over attendance by the students of the sessions. If participants did not attend the preceding face-to-face class sessions their exposure to the knowledge would have been different to that of other participants. This non-attendance may have resulted in a lower score, especially in the pre-achievement-test, due to the lack of newly acquired knowledge.

Place: Except for the first learning style measurement session in 2010 all the sessions could be booked at the same computer laboratory. A familiar environment that did not distract the focus of the participants during the data capturing session could thus be provided.

Availability of the scores: The pilot study results indicated that the availability of the scores of the achievement tests may have influenced the attitudes of the students. This may have created a confounding variable that would have been difficult to control. It was decided that the scores should not be made available in subsequent data capturing sessions.

Time: It was attempted to do all the data capturing sessions at the same time of the day. Due to pre-booking of the computer laboratory by other users, two of the sessions each year had to be done half an hour earlier than the others.

External validity: The use of a convenient sample at only one university limited the ability to generalise the results to other universities. Even though selection criteria for occupational therapy students may be similar at the different universities in South Africa, the results of this study may only be generalised to the first year occupational therapy students studying at the University of Pretoria.

Reliability of the study: The repeated measure of the data capturing process addressed the possible individual personal factors that could have impacted on the performance of the students. The repetition of the tests on four different occasions allowed for an average change between the pre-and post-achievement-tests that provided a more reliable result.[91]

3.4.4 Data collection and recording

Data collection took place according to the process as illustrated in Fig 3.1 and discussed in the process and design of the study in 3.2. The type of data collected for each objective was done according to the type of data and the methods specified.

Phase One (Objective 1) was conducted in the first semester of each year. Phase Two (Objectives 2 and 3) was completed in the second semester of each year.

No additional data capturing was required for Objective 4.

Because the challenges that were experienced during the data recording were often similar for more than one session these challenges will be discussed collectively.

Data for each objective was captured according to the four digit numbers recorded by the participants at the first session. Data capturing for each of the first three objectives will now be discussed in more detail.

Phase One: Felder-Soloman Index of Learning Style Test. (Objective 1) Early in 2010 the first data capturing session was done. During this session numbers were taken from a box and recorded on a class list by the students. Consent forms were completed and the Felder-Soloman ILS test done. The session took place in the computer laboratory most often used for test and exam purposes. This being the first introduction to the computer laboratory for most

of the first year occupational therapy students resulted in uncertainty and some confusion. The procedure to gain access to the intranet had to be explained before the session could commence. Communication in this laboratory was difficult resulting in more time required to make sure all the students understood what was expected.

In 2011 the first data capturing session was done in the computer laboratory used for lectures and tests. Communication with the students was easier even though some confusion due to the new environment was still experienced. The same procedure as in 2010 was followed with this group of students.

The Felder-Soloman ILS test was completed on the computers by participants and submitted to the University's mainframe. The dichotomous data for each participant were manually resubmitted to the internet for scoring and interpretation. The data were saved on the mainframe of the University of Pretoria. After manual submission of the raw data the results were saved for analysis and to be made available to the participants.

Phase Two: Achievement test and experience survey. (Objective 2 and 3)
Classes in Biomechanics commenced early in the second semester. All the students were expected to attend one two hour face-to-face session per week. During these face-to-face sessions the course outcomes were taught according to the prescribed curriculum available in Appendix A. Data capturing sessions took place during every third class session.

All the first year occupational therapy students participated in the data capturing sessions. It formed part of a class session needed for completion of the subject. Students that were absent at the first session in the first semester and thus did not complete consent forms did not have numbers. The numbers not chosen at the first session were noted, kept and made available to the students that did not have numbers. These numbers were allocated to these non-participating students to maintain anonymity.

Because the first data capturing session happened a few months earlier it was deemed necessary to explain the purpose and procedure of the study again at the start of the first pre-and post-achievement test session. The participants were reminded that they may withdraw from the study at any time by using one of the numbers that were available for non-participants.

Each of the four data capturing sessions followed the same format. The same four digit numbers were used throughout. Immediately before starting each achievement test a unique password was made available to the participants. The passwords were supplied by the programmer to obtain access to each test.

The pre-achievement test was completed first. At each session there were some participants that needed technical assistance with their computers but no challenges were experienced in the understanding of the test questions. On completion of the pre-achievement test the relevant content in the interactive '*Basic Biomechanics for therapists*' CD was indicated and could be accessed according to the needs of the individual participant.

Time was allowed for individual interaction with the CD learning resource. Participants were allowed to explore and find information on their own. Technical assistance was once again available for computer related problems where necessary. After 40 minutes the participants were instructed to close the intervention CD and to take a five minute break.

After the break the next password for completion of the post- achievement test was provided. When everybody finished the post achievement test the final password to gain access to the experience survey was made available. On completion and submission of the experience survey, participants were allowed to leave the venue.

The only deviation from the planned routine was experienced in the changed starting time for sessions one and three. In both 2010 and 2011 the

first and third sessions had to start 30 minutes earlier than the usual class time. The participants were told in advance of the change in the starting time.

Data for the pre- and post-achievement tests were measured as continuous interval data[102] and recorded as scores out of twenty, reflected as a percentage. All the first year occupational therapy students at the University of Pretoria participated in the session but only the data of the participants that completed consent forms were used for data analysis.

Data for the experience survey were measured as discrete ordinal data.[103] Data were recorded according to the positive or negative response allocated to each question on a Likert scale as illustrated in Table 3.1. The same experience survey was completed after each of the four sessions.

Management of challenges experienced: Challenges experienced during data recording were mainly related to programming and the four digit numbers. The manner in which these challenges were managed will now be described:

Four digit numbers: In 2010 the name list on which the numbers was recorded at the first data capturing session, was available at the first session of Phase Two, it was however not available at the second of these sessions. This resulted in four participants using their student numbers to gain access to the achievement tests because they could not remember their four digit numbers. The use of student numbers made it possible for the researcher to identify the participants that could probably lead to bias. To prevent this probable bias the researcher accessed the data only after the completion of the final exams. For Subsequent sessions in 2010 and 2011 the class list was placed on a table to be used by the participants to confirm their numbers before the start of each session.

Pass words: At the third achievement test data capturing session in 2010 the unique password for access to the experience survey was not programmed correctly. This technical problem could not be resolved and the participants

had to use their computer numbers instead of the four digit numbers to register to the system. The computer numbers and four digit numbers were recorded on slips of paper to enable the researcher to manually link the data with the correct four digit numbers at the end of the year.

At the third and fourth achievement test sessions in 2011 there were once again problems with the programming of the password for the completion of the experience survey resulting in a 20 minute delay. These programming problems frustrated the participants and may have impacted on their responses to the survey questions.

Incorrect numbers: Two participants used incorrect four digit numbers to register for the second post-achievement-test in 2010. When the participants whose numbers were incorrectly used by other participants wanted to use their allocated numbers they could not get access to the tests. These incidents were reported to the researcher and the relevant numbers and alternative numbers used for the particular session were recorded. When the data was processed at the end of the year the appropriate computer addresses were used to match the correct numbers to the correct data.

The researcher processed the data according to the numbers that the participants recorded on the class lists. The data of the non-participants was removed before statistical analyses were performed.

3.4.5 Data analyses:

Data for each objective was analysed according to the type of data obtained. Analyses that were performed in order to reject or fail to reject[103] the null hypotheses are provided in Chapter 4. Analyses will be discussed according to the four objectives.

STATA 11 was the software used for all the analyses undertaken.

Learning style tests: (Objective 1) The Felder-Soloman ILS test was used to identify the learning-styles profiles of the participants according to the combination of the four learning domains identified by the test. Each domain consists of two opposite proponents of which one has to be dominant.[63]

Each domain consists of two opposite proponents that are measured by 11 out of 44 questions. These 11 questions are allocated positive or negative values to distinguish between the two proponents that each domain consists of. The number of questions chosen for each proponent are added together and then subtracted from each other to determine the weight value for the dominant proponent. The weight values thus provide positive or negative nominal data that are reflected on a linear scale to indicate the weight representation of the more dominant proponent for each domain.[63] Each domain thus consists of a positive or negative value to identify the dominant proponent. The positive and negative values are used solely to distinguish between the proponents and do not signify negative or positive attributes.

The multivariate one group nominal dichotomous data was analysed to identify the four learning style domains.[92,104] A descriptive analysis was done using the following analytical processes:

- The frequency of proponents according to each domain was reflected in a simple frequency distribution table.
- The Mann-Whitney equality of population rank test was done with the non-parametric data to compare the domains between the two year groups. Significance is indicated as $p \leq 0.05$.
- A multiple/joint correspondence analysis was conducted for each year group to make it possible to confirm the similarities in the distribution of the proponents of the learning-styles.

Achievement tests: (Objective 2) To determine if the intervention tool had an effect on the achievement of the participants the mean change for the four pre- and post- achievement tests for each participant was calculated. These individual mean changes were reflected as continuous interval data to be used to determine the mean change for the group.

- Comparative analyses for significance were done with the use of paired t-tests. Each achievement test was assessed individually for each year-group and then for the two groups combined.
  Correlation between the pre- and post-achievement test performance scores were then determined. Mean scores were calculated and a standard error calculated. A confidence interval of 95% was applied to determine the performance scores and indicate the percentage change between the two tests.
- A global analysis with the use of the anova-change test for possible adjustment of the achievement-test scores was conducted.
- A co-variance analysis was conducted to compare the tests with respect to the final performance scores adjusting for the differences between the pre- achievement-tests.

The hypothesis was tested and a t>0.05 level of significance was required. A two-tailed analysis was used because positive and negative changes were possible.[104,105]

STATA 11 was used as the analysis tool.

Experience survey: (Objective 3) To determine if the participants experienced the use of the interactive 'Basic Biomechanics for therapists' CD as positive or negative the data was obtained as discrete ordinal data. The data was obtained according to a Likert scale ranging from 'strongly agrees' to 'strongly disagree' as reflected in Table 3.1. The scores were converted into binary data and analysed as nominal data. The key for the conversion of the data is indicated in Table 4.2

TABLE 4.2: Key used for the conversion of the experience survey data into binary data

Values 1-3 = 0 indicating a negative or neutral comment.
Values 4-5 =1 indicating a positive comment

- An analysis of variance was performed with the data for the experience survey to be reflected in a simple frequency distribution table.[92] The sum total of the positive responses to each question and the sum total of the negative responses are reflected as a percentage of the total.
- The Fishers exact with a probability level of $p<0.05$was used to measure the possible association between the four tests for each of the ten questions.
- The Chronbach alpha test was used to analyse the internal consistency reliability coefficient for the experience survey.[92]

Relationship between learning style proponents and achievement: (Objective 4) The results obtained from the data analyses done for objectives 1 and 2 were used in combination.

Each of the eight proponents of the learning-styles were analysed separately. The mean score change in the achievement for each proponent were determined according to the mean score change for the four achievement-tests of each participant the proponent was identified for.

- Paired t-tests were done to identify the change for each proponent.
- Correlational analyses were done to determine possible relationships between the mean change for each of the four tests for the participants and each learning style proponent.

Any change between the pre-and-post-achievement-tests is regarded as significant.

3.4.6 Ethical considerations

Ethical principles to ensure adherence to professional and moral obligations were implemented during the study.[91] Elements that were considered in these ethical considerations were; participation, benefit or risk, confidentiality, availability of results and ethical clearance.

Participation: Participation in the study was entirely voluntary and anonymous. The elements considered to protect the participants were as follows:

- Participants did not compete against anybody else and no physical interventions were applied.
- Voluntary participation was obtained as written voluntary informed consent.[94]
- The use of randomly chosen four digit numbers protected the anonymity of participants.[91] In cases where non-participants had no numbers, measures were taken as described in 3.3.2 to maintain anonymity.
- There were no adverse consequences for non-participation.

Benefit or risks: The benefit of the study to the participants was the exposure to subject outcomes in a different format. It provided the participants the opportunity to study the outcomes on their own and at their own pace. It provided additional preparation for formative and/or summative assessment during and at the end of the course.

No extra time demands were made on the participants because data capturing sessions were done during scheduled class time. Withdrawal from the research programme was possible at any time without any repercussions. The name list on which the four digit numbers were recorded was kept in the safe of the Occupational Therapy Department at the University of Pretoria. The list was made available to participants for confirmation of their numbers before sessions. The researcher was present at each data capturing session but the name list was available only to the participants. After the participants completed the exams for Biomechanics, the list with the recorded four digit numbers was made available to the researcher.

Marks obtained in the achievement tests had no effect on the test or exam marks needed to pass the subject. Thus participation in the study held no risks to the participants.[91]

The Hawthorn Effect may have been present in the behaviour of the participants because they consented to participate in the study. They may have been more concerned to show involvement in the subject than they would otherwise have done. It may have been true for the students that would not naturally use a multimedia interactive learning resource. More effort may have resulted in better than usual marks for the achievement tests. The participants did not compete against each other thus the effect of possible higher marks would not compromise the results of the study.

No risks to the participants to the study were identified.[91]

Confidentiality: Collected data were kept on the mainframe of the University of Pretoria and on the computer of the researcher to protect confidentiality before collation and analysis of the data commenced at the end of data capturing. Both the mainframe and computer are protected by passwords known only to the researcher and the administrator for the main frame.[106] Data were available according to the four digit numbers only, except for the few participants that used their student numbers for one test as discussed in

3.6. All data will be stored by the University of Pretoria in a storage facility when the study is completed.

Availability of the results: At the conclusion of this study the results of the learning style tests were made available to the participants. A result sheet identifying their specific learning style domains, together with information on the interpretation of the results were provided. Suggestions on how to adapt their own study methods to these learning style domains were made available to the participants. An example of the learning strategies information provided is available in Appendix G

Articles on the results of the study will be published in accredited journals. The results will also be shared with the staff members of the Occupational Therapy Department in view of the possible development of other a-synchronous e-learning resources.

The identified learning style profile of the group will be made available to the staff members of the occupational therapy department for possible utilisation in the respective modules.

Ethical clearance: Permission to conduct the study was obtained from the Head of the School of Health Care Sciences and the Head of the Occupational Therapy Department.

Approval was obtained from the following committees:

- Research and Post Graduate Committee of the School of Health Care Sciences of the University of Pretoria
- Ethics Committee of the Faculty of Health Sciences (Protocol number: S163/2009). [91]
- Academic Advisory Committee of Health Care Sciences
- Faculty Board of the University of Pretoria

All the above ethical considerations were included in the research protocol presented for ethical clearance and instructional review.

3.5 Summary

A quantitative study was conducted over a two year period. A convenient sample including all the first year occupational therapy students studying at the University of Pretoria was used. The study was conducted as part of the Biomechanics classes in the second semester and was managed according to the prescribed outcomes of the curriculum. Participation was voluntary with no risks to any of the participants.

Four objectives were studied in three phases. Each objective had to be achieved according to a different design and statistical analysis.

The first phase of the study to determine the learning style profiles of occupational therapy students studying at the University of Pretoria was conducted according to a cross-sectional descriptive design.[77]

The second phase of the study was done according to a cross-sectional design with a pre-test-intervention-post-test repeated timeline method.[94] The intervention tool used was the interactive 'Basic Biomechanics for therapists' CD. Pre- and post- achievement tests were done to determine change in the achievement of the participants studying Biomechanics. The experience survey (Objective 3) that formed a part of this second phase was done as a repeated measure descriptive design.[98]

The third phase was done according to a correlational design[104] to determine a possible relationship between the achievement and the learning style proponents.

To increase the validity and reliability of the study the variables applicable to the study were identified and controlled. Ethical considerations were identified and addressed in such a manner that no unspecified limitations on the data were caused and no individual rights were infringed upon.

The researcher has been the lecturer presenting Biomechanics to the first year occupational therapy students at the University of Pretoria for the past ten years. The interactive *'Basic Biomechanics for therapists'* CD was developed by the researcher and used as intervention tool.

The study was done under the supervision of competent staff members at the University of Pretoria at all times to ensure that all the ethical principles as specified were adhered to.

In the next chapter the results of the research will be described in more detail.

CHAPTER 4

RESEARCH RESULTS

4.1 Introduction

Data was collected according to the requirements of each of the first three objectives. After completion of this data capturing the quantitative data obtained had to be analysed. The analysis for Objective 4 could be conducted with the use of the data obtained for the first two objectives. Each objective was analysed separately according to the type of data that were gathered. The results of these analyses will be described in the sequence they were completed.

In this chapter the following are included:

- The exposition of the biographical sample.
- Data results for Objective 1.
- Data results for Objective 2.
- Data results for Objective 3.
- Data results for Objective 4.

4.2 The exposition of the biographical sample

This study was conducted at the University of Pretoria. Only first year occupational therapy students took part in the study. As discussed in 1.1 a

limited number of students are selected each year. The total sample group for this study thus consisted of N=81 participants.

Traditionally occupational therapy students studying at the University of Pretoria are predominantly female. Only one of the participants to the study was male, resulting in 98.8% of N being female.

Language was identified as the main background difference that divided the sample group into three groups namely 28.4% English, 64.2% Afrikaans and a small group of 7.4% representing other languages. Cultural differences identified were minimal and the only difference of note was that 95.1% of the sample was Western and 4.9% other ethinc groups. There were no participants from poor rural areas. The identified differences are reflected in Table 4.1.

TABLE 4.1: Different languages and ethnicity

	Number of participants 2010 N=39	**Number of participants 2011 N=42**	**Percentage of total**
Home language			
Afrikaans	26	26	64.2
English	10	13	28.4
Other	3	3	7.4
Cultural group			
Western	38	39	95.1
Indian/Asian	1		1.2
Coloured		1	1.2
African		2	2.5

4.3 Results for Objective 1

Objective 1 was to determine the learning style profiles of the first year occupational therapy students studying at the University of Pretoria.

4.3.1 Identification of learning-styles

A descriptive analysis was used to reflect the one group nominal dichotomous data in a frequency distribution table.[97] Each person's learning style profile consists of four domains with one dominant proponent for each domain. The proponents are reflected as opposites on a linear scale as positive or negative values.

The proponents that are identified as positive values are reflected in the first column with the proponents identified as negative values in column four. Each row represents a domain with the two representative proponents. The results for each of the eight proponents that constitute the four domains are reflected in Table 4.2.

TABLE 4.2: Relative scores by domain for N81

Positive Proponents	N	Percentage	Negative Proponents	N	Percentage	Total N
'active'	49	60.5%	'reflective'	32	39.5%	81
'sensing'	57	70.4%	'intuitive'	24	29.6%	81
'visual'	68	84.0%	'verbal'	13	16.0%	81
'sequential'	59	73.0%	'global'	22	27.0%	81

The most frequently represented proponents are: 'active', 'sensing', 'visual' and 'sequential'. These four proponents thus represent the majority learning style profile of the sample group.

The inclusion of the weight allocation of the questions identifying the different proponents resulted in a confirmation of the findings of the simple frequency distribution. See table 4.3. The 'active', 'sequential', 'visual' and 'sensing' proponents were again found to be the most represented.

TABLE 4.3: Reflection of the frequency and weight of representation for each proponent N81

Positive Negative	**Active Reflective Frequency**	**%**	**Sequential Global Frequency**	**%**	**Sensing Intuitive Frequency**	**%**	**Visual Verbal Frequency**	**%**
11	3	3.70%	3	3.70%	6	7.41%	4	4.94%
9	0	0.00%	2	2.47%	5	6.17%	11	13.58%
7	6	7.41%	7	8.64%	8	9.88%	16	19.75%
5	15	18.52%	13	16.05%	8	9.88%	16	19.75%
3	15	18.52%	17	20.99%	19	23.46%	13	16.05%
1	11	13.58%	18	22.22%	10	12.35%	8	9.88%
-1	15	18.52%	6	7.41%	9	11.11%	5	6.17%
-3	7	8.64%	8	9.88%	5	6.70%	6	7.41%
-5	4	4.94%	3	3.70%	3	3.70%	2	2.47%
-7	4	4.94%	3	3.70%	1	1.23%	0	0.00%
-9	1	1.23%	1	1.23%	7	8.64%	0	0.00%
Total	81	100 %	81	100%.	81	100%	81	100%
Positive Negative Diff:	Active Reflective	61.73% 38.27% 23.46%	Sequential Global	74.07% 25.93% 48.15%	Sensing Intuitive	69.14% 30.86% 38.27%	Visual Verbal	83.95% 16.05% 67.90%

To assess if there is a difference between the learning style profile of the 2010 and 2011 year groups the non-parametric Mann-Whitney test was used to

compare the groups with each other. The comparison was conducted between learning style domains. The results are reflected in table 4.4 with a table value of p≤0.05.

The analyses indicate no significant difference between the two year groups, confirming that the profile for the participant in 2010 and 2011 is similar.

TABLE 4.4: Comparison between 2010 and 2011 learning style domains

Learning style domain	Probability score
'Active'/ 'Reflective'	p=0.52
'Sequential' 'Global'	p=0.10
'Sensing' / 'Intuitive'	p=0.43
'Visual' / 'Verbal'	p=0.90

The scores obtained from the Mann-Whitney test were converted to ranks that were used in a multiple/joint correspondence analysis of frequency.[94] A correspondence analysis was conducted to determine the relative distribution of the learning style proponents. The relativity in the order of similarity is reflected on two dimensions resulting in four quadrants. Each year group was done separately to identify similarities as seen in figure 4.1. and 4.2.

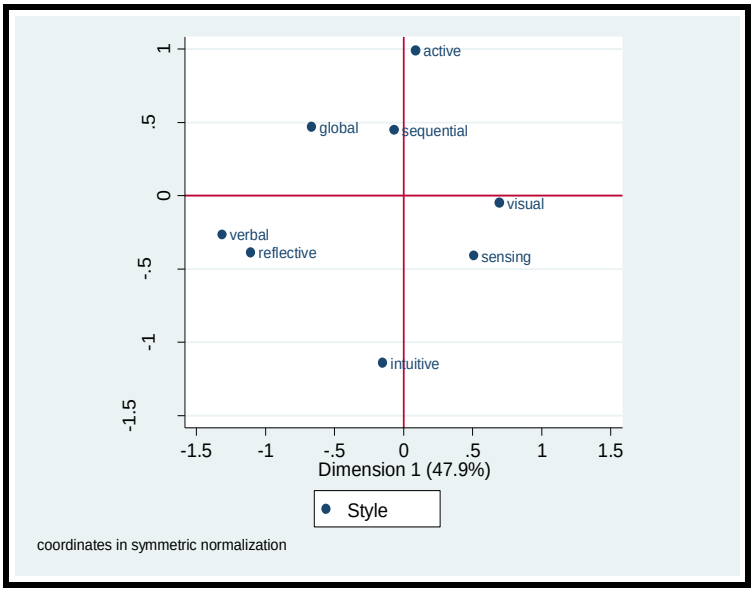

FIG 4.1: Level of correlation for learning style proponents 2010

The relative distribution of dimension one represents 47% and dimension two 34% of the sample. The highest positive value on dimension one is the 'visual' proponent. The highest positive value on dimension two is the 'active' proponent. The highest negative value on dimension one is the 'verbal' proponent. The highest negative value on dimension two is the 'intuitive' proponent.

Three clusters could be identified indicating a close association between the appropriate proponents. 'Verbal' and 'reflective', 'global' and 'sequential' and 'sensing' and 'visual' proponents are situated relatively close together indicating an association with each other. The 'active' and 'intuitive' proponents do not have an association with any of the other proponents.

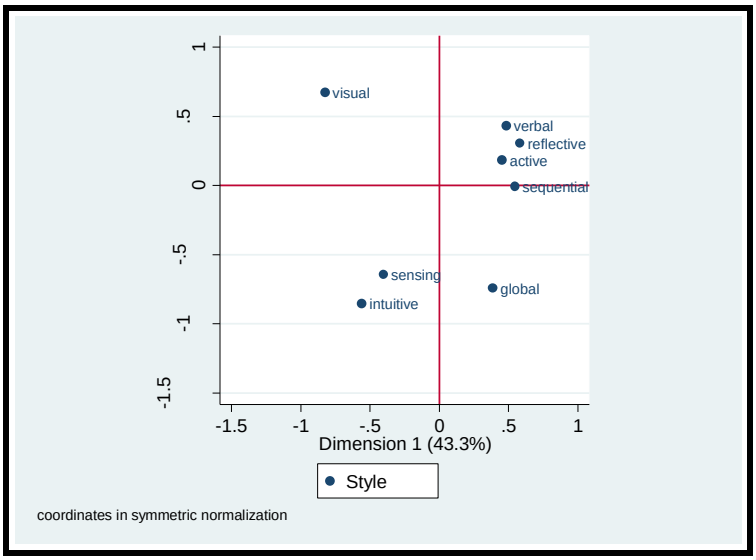

FIG 4.2: Level of correlation for learning style proponents 2011

The relative distribution of dimension one represents 43% and dimension two 28% of the sample. The highest positive value on dimension one is the 'sequential' and 'reflective' proponents. The highest positive value on dimension two is the 'visual' proponent. The highest negative value on dimension one is the 'visual' proponent. The highest negative value on dimension two is the 'intuitive' proponent.

Two clusters could be identified indicating a close association between the 'active', 'reflective', 'verbal' and 'sequential' proponents and the 'sensing' and 'intuitive' proponents are lying close together. The 'global' and 'visual' proponents do not have an association with any of the other proponents.

A final combined multi/joint correspondence analysis was conducted with the data of both 2010 and 2011 to explore the relationship between the non-metric variables as seen in Fig 4.3.

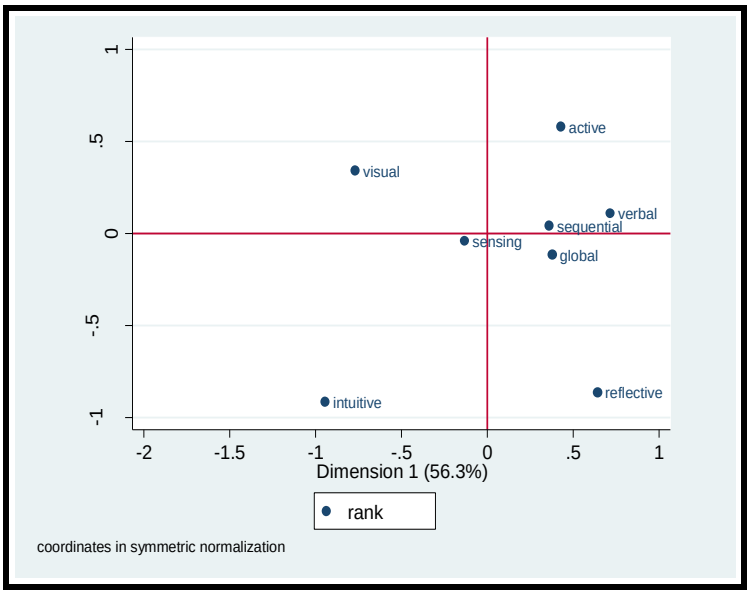

FIGURE 4.3: Level of correlation for 2010 and 2011 combined

The relativity of similarity between 2010 and 2011 is confirmed in the distribution of the learning style proponents as seen in Fig 5.3.

The relative distribution of dimension one represents 56.3% and dimension two 25.9% of the sample. The highest positive value on dimension one is the 'visual' proponent. The highest positive value on dimension two is the 'active' proponent. The highest negative value on dimension one is the 'reflective' proponent. The highest negative value on dimension two is the 'intuitive' proponent.

Only one cluster is identified indicating a close association between the 'sensing', 'global', 'sequential' and 'verbal' proponents. The 'visual', 'active', 'reflective' and 'intuitive' proponents do not have an association with any of the other proponents.

4.3.2 Conclusion:

The most dominant learning style profile representative of the first year occupational therapy students studying at the University of Pretoria between 2010 and 2011 consists of the 'active', 'sensing', 'visual' and 'sequential' proponents.

The most dominant of these is the 'visual' proponent. No significant difference between the two year groups was identified.

4.4 Results for Objective 2

Objective 2 was to determine the effect of the interactive 'Basic Biomechanics for therapists' CD on the learning measured as achievement of first year occupational therapy students studying Biomechanics at the University of Pretoria.

4.4.1 Identification of change in achievement:

A comparative analysis was performed with the continuous interval data of each of the four achievement test sessions to determine significance in the change between the pre- and post- achievement tests. The mean scores of the group, for each pre- and post-achievement test, were determined according to the mean scores obtained by each participant for each pre- and post-achievement test. A comparative analysis for significance was conducted with the use of paired t-tests for each of the four sessions. The results are reflected in Table 4.5.

TABLE 4.5: Summary statistics for the four achievement tests

Test 1	**Pre-test**	**Post-test**	**Change**
Mean	68.51	79.53	11.01
95% Confidence Interval	65.79 - 71.23	77.02 - 82.03	8.53 - 13.50
Test 2	**Pre-test**	**Post-test**	**Change**
Mean	66.62	68.60	1.98
95% Confidence Interval	63.82 - 69.41	66.95 - 71.26	-0.61 - 4.58
Test 3	**Pre-test**	**Post-test**	**Change**
Mean	47.66	57.98	10.32
95% Confidence Interval	44.27 - 51.05	55.09 - 60.88	6.27 - 14.37
Test 4	**Pre-test**	**Post-test**	**Change**
Mean	53.94	55.55	1.62
95% Confidence Interval	51.19 - 56.68	53.10 - 58.01	-1.04 - 4.27

A global analysis of the post-achievement-test scores to compare the tests with respect to the final performance scores adjusting for the differences in the pre-achievement-test score was conducted. Clear evidence was found to prove that performances varied globally from test to test as indicated in Table 4.6.

TABLE 4.6: Distribution of the four achievement test scores

Test	**Mean change**
1	11.01
2	1.98
3	10.32
4	1.62

Because the distribution of the scores for the four tests differed from each other, a contrast test was conducted to determine the significance of the difference between the four achievement tests. A significant difference was found between tests 1 and 2 and tests 3 and 4. No significant difference between tests 1 and 3 or tests 2 and 4 was identified.

A further comparative analysis was performed with the continuous interval data of each of the four achievement tests to determine significance in the change between the pre- and post- achievement tests. An overall analysis of the pre-and-post-achievement-test scores to evaluate differences between tests adjusting for the pre-test score was done with the use of the anova-change test. The adjusted means by test globally are reflected in table 4.7.

TABLE 4.7: Adjusted means for the post-achievement-tests

Test	Adjusted mean	Confidence interval
1	79.52	77.27 - 81.78
2	68.41	66.07 - 70.74
3	58.38	55.98 - 60.79
4	55.55	53.15 - 57.96

Minimal adjustment of the post-achievement-test scores was indicated. There is however clear evidence to prove that performances varied generally when assessed over all the tests.

A co-variance analysis was finally conducted to determine the significance of the difference between the pre-and adjusted post-achievement-test scores globally. With a table value of t>0.05, the result of this analysis found a t=0.00 value providing evidence that there is significant improvement in

achievement between the pre-and-post-achievement-tests. The null hypothesis could thus be rejected.

A pictorial representation of the parameters by test is reflected in a box and whisker plot in Fig 4.4. The mean scores and change in each test are reflected. The upper and lower quartiles of the data as well as the minimum and maximum scores are indicated.

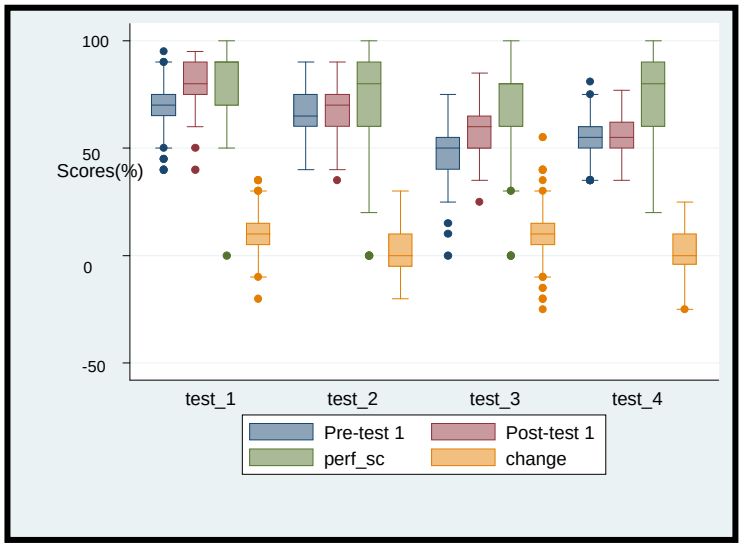

FIGURE 4.4: Pictorial representation of the parameters by test

Tests two and four indicated negative change for the lower quartile with this quartile being below the zero line. The range of dispersion for each test is different with the median indicating different distributions of the scores.

Equal distribution of data is observed in pre-achievement-tests one and four. Pre-achievement-test two and post-achievement-tests one and four all reflect positive skewed distribution of scores, indicating a group of scores strung out towards the higher score continuum.[97] Pre-achievement-test three and post-achievement-tests two and three all reflect negative skewed distribution, indicating a group of scores strung out towards the lower continuum.[97]

4.4.2 Conclusion:

A significant difference was identified between the pre-and-post-achievement-tests and the null hypothesis could thus be rejected with a t=0.00 value. Tests one and three showed the biggest positive change between the pre- and post- achievements tests. Tests two and four were similar in mean change and even though the change was still positive the margin of change was smaller. Further interpretation of this will be discussed in chapter 6.

4.5 Results for Objective 3

Objective 3 was to determine the experience of the first year occupational therapy students studying at the University of Pretoria using the '*Basic Biomechanics for Therapists* 'CD as a learning resource.

4.5.1 Identification of experience:

A simple frequency distribution table was compiled.[97] The original ordinal data was converted to binary nominal data to reflect positive or negative responses to each question. The responses were reflected as a percentage of the total.

The Fishers exact was used to measure the association between each of the questions and the four achievement tests. The results are reflected in table 4.8.

TABLE 4.8: Frequency distribution and association between tests

Question	Value	Frequency test 1	Frequency test 2	Frequency test 3	Frequency test 4	Percentage for total	Fisher's exact
1	0	2	6	8	9	9.29	
	1	72	62	54	56	90.71	0.07
2	0	1	6	3	4	5.20	
	1	73	62	59	61	94.80	0.21
3	0	14	23	21	28	31.97	
	1	60	45	41	37	68.03	0.02
4	0	6	12	8	13	14.50	
	1	68	56	54	52	85.50	0.18
5	0	46	36	41	39	60.22	
	1	28	32	21	26	39.78	0.48
6	0	9	12	10	13	16.36	
	1	65	56	52	52	83.64	0.64
7	0	7	12	15	14	17.84	
	1	67	56	47	51	82.16	0.10
8	0	3	4	1	4	4.46	
	1	71	64	61	61	95.54	0.60
9	0	27	26	21	18	34.20	
	1	47	42	41	47	65.80	0.59
10	0	11	22	24	23	29.74	
	1	63	46	38	42	70.26	0.01

A significant association between the replies for all questions except questions three and ten were indicated. The results for all the questions were conclusive in the positive except for question five. Question five was found to have a higher incidence of negative answers. The implications of the results

on the individual questions will need further explanation and will be discussed in Chapter 5.

4.5.2 Reliability of the survey:

The Chronbach-alpha test was used to analyse the internal consistency reliability coefficient for the experience survey. The reliability of the survey was confirmed by an increase in the reliability coefficient for each test with the first starting at a moderate reliability of 0.44 and the fourth achievement test at a good reliability of 0.75. The combined results for all the surveys on all ten questions indicate a scale reliability coefficient of 0.64 which according to Walker 2010[105] indicates a moderate reliability.

4.5.3 Conclusion:

The internal consistency found in the analysis confirmed that there was similarity between the results of the four experience surveys.

4.6 Results for Objective 4

Objective 4 was to determine the possible relationship between the learning style domains and the achievement measured over four achievement tests.

Each of the eight proponents of the learning-styles were analysed separately to determine the relationship between each proponent and the mean score changes of each participant. The mean score change in the achievement

for each proponent was determined according to the mean score change for the four achievement- tests of each participant.

4.6.1 Relationship between each learning style proponent and the change in achievement

Paired t-tests were conducted, with the mean change in the achievement of each participant for each of the four achievement tests. These mean scores were then grouped according to each learning style proponent to identify the mean change in each of the four tests.

The relationship between the proponents and the mean change between the pre-and-post-achievement-tests globally are reflected in table 4.9.

TABLE 4.9: Relationship between learning proponents and mean change in the achievement tests

Proponents	'active'	'reflective'	'sensing'	'intuitive'	'visual'	'verbal'	'sequential'	'global'
Mean post-tests	64.78%	66.90%	65.49%	63.98%	65.83%	63.98%	64.61%	68.39%
Mean pre-tests	58.08%	61.51%	59.12%	59.53%	59.00%	59.60%	57.69%	63.59%
Change	6.70%	5.39%	6.37%	4.45%	6.23%	4.38%	6.92%	4.80%

Changes above 5% were measured for the 'sequential' 6.92%, 'active' 6.70%, 'sensing' 6.37%, 'visual' 6.23% and 'reflective' 5.39% proponents. The 'verbal' 4.38%, 'intuitive' 4.45%, and 'global' 4.8% proponents reflected lower than 5% change.

Correlational analyses were done to determine possible relationships in the change between these scores. The relative changes between the tests are illustrated in the pictorial reflection in a bar-graph of the results in figure 4.5

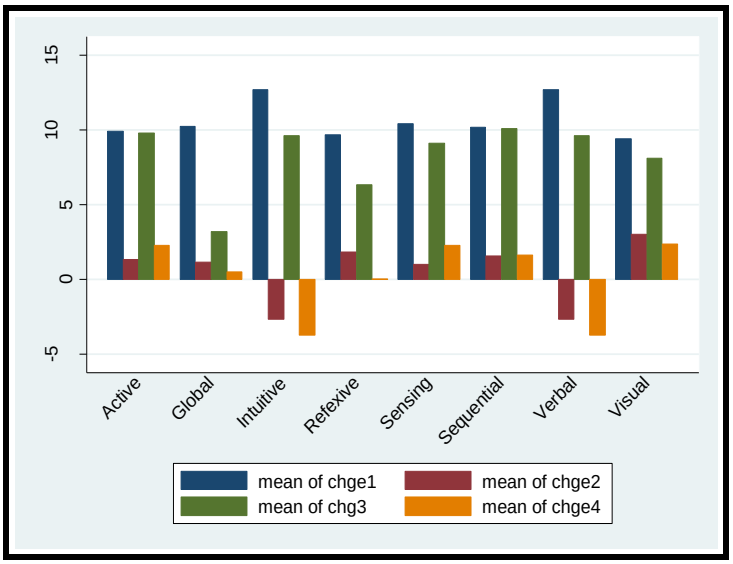

FIGURE 4.5: Relative changes over four tests between the different learning proponents

The results indicated in Fig 5.5 show that tests two and four consistently improved by less than 5% mean change. Some negative changes took place in the 'intuitive' and 'verbal' proponents for tests two and four. Except for the 'global' proponent, tests one and three reflect mean changes well above 5%.

4.6.2 Conclusion:

The 'sequential', 'active', 'sensing', 'visual' and 'reflective'_proponents all indicate an improvement above 5% average over the four tests. The 'verbal',

'intuitive', and 'global' proponents have a lower than 5% average change. The implications of these findings will be discussed in Chapter 5.

4.7 Summary

The sample group consisted of 98.8% female participants. A large proportion of participants at 64.2% were Afrikaans speaking implying that the majority of the participants were receiving instruction in their second or third language. A majority of 95.1% of the sample group was Western resulting in minimal cultural differences within the group.

The statistical analyses identify the most dominant learning style profile of the first year occupational therapy students studying at the University of Pretoria as consisting of the 'active', 'sensing', 'visual', and 'sequential' proponents. The most dominant of these proponents are found to be the 'active', 'visual' and 'sensing' proponents.

Results on the mean change between the pre-and post-achievement tests indicate a positive change in all four the tests. There was a marked difference in the mean change between the four tests. However, the combined results showed a significant improvement with t=0.000 making it possible to reject the null hypothesis.

The reliability of the experience survey was confirmed as reflected in the constant improvement of the reliability coefficient from the first to the last test resulting in a moderate reliability score of 0.64 for all the tests combined. The survey confirmed that the use of the intervention tool was experienced as positive.

Correlational analyses between the learning-styles and the achievement tests indicated a strong relationship with the results of the pre- and post-achievement tests. Change ranging between 4.3% and 6.9% were measured

with the ‘sequential’, ‘active’, ‘sensing’ and ‘visual’ proponents all improving by more than 5%.

The implications of the results will be discussed in more detail in the next chapter.

CHAPTER 5

RESEARCH CONCLUSION

5.1 Introduction

The focus of the research was on determining the effect of the interactive *'Basic Biomechanics for therapists'* CD on the achievement and experience of the first year occupational therapy students studying at the University of Pretoria. A learning style profile was established and the relationship between this learning style profile and the change in achievement was determined. The implications and relevance of these findings will be discussed according to the results provided in the previous chapter.

The research objectives had to be answered in order to achieve the aim of the study.

In this chapter the following will be included:

- Summary of the findings
- Limitations of the study
- Main conclusions
- Recommendations for implementation
- Suggestions for further research

5.2 Summary of findings

The question as identified in 1.3.1 was:

Based on their learning-styles, will this interactive multimedia CD *'Basic Biomechanics for therapists'* have an effect on the first year occupational therapy students' learning of Biomechanics when studying at the University of Pretoria?

5.2.1 Objective One

What are the learning style profiles of the first year occupational therapy students studying at the University of Pretoria?

The four proponents that represent the learning style profile of the sample group in 2010 and 2011 consist of the 'active', 'sensing', 'visual', and 'sequential' proponents. These proponents were the same as those identified for the participants to the pilot study. The learning style profiles for the first year occupational therapy students between 2009 and 2011 were thus found to be consistent. The 'visual' proponent was found to be the most dominant proponent.

Considering the distribution of the learning style proponents for the total population a close association between the 'sensing', 'global', 'sequential' and 'verbal' proponents was identified. The 'visual', 'active', 'reflective' and 'intuitive' proponents have no association with any of the other proponents.

When compared to the learning style profiles of occupational therapists in studies done in other countries with the Kolb LSI test[10-12,46] some similarities were identified. The 'active' and 'sequential' proponents were repeatedly identified according Kolb's LSI test and the VARK [12] test.

Different results were however found in the study done by Weiss[66] with the Felder-Soloman ILS test as mentioned in 2.4. The learning proponents identified in this study were 'reflective', 'sensing', 'verbal', and 'global'. Weiss[66] concluded that the only proponent that could be regarded as dominant is the 'global' proponent.

Sufficient similarities were thus not identified to accept that learning style profiles of occupational therapy students in different countries are similar to those in South Africa at the University of Pretoria.

5.2.2 Objective Two

Will the interactive *'Basic Biomechanics for therapists'* CD have an effect on learning and thus the achievement in Biomechanics by the first year occupational therapy students studying at the University of Pretoria?

The results obtained for all the achievement-tests done by the sample group over a two year period showed an improvement in the mean scores of the post-achievement tests. This improvement is in line with the result of the pilot study where a smaller sample group was used and only one achievement-test done. The improvement in achievement was thus confirmed and the null hypothesis could be rejected. It could thus be concluded that the interactive *'Basic Biomechanics for therapists'* CD had a positive effect on the learning, measured as achievement, of the sample group.

At closer examination of the results on the mean change between the four pre-and post-achievement tests as indicated in table 4.4, it is clear that there are marked fluctuations between the mean changes of the four achievement tests. These results were consistent for both year groups and could thus not be regarded as coincidence. The differences in the level of

change between the four individual tests were of such a nature that further questions had to be asked.

In order to investigate all possible reasons that may have contributed to these fluctuations in the mean change between the four achievement tests, the physical data capturing process needed to be examined first.

During the data collection process external changes in the process were present. As discussed in 3.6, the starting time of sessions one and three was earlier by 30 minutes for each year group. Results showed that the mean change in these two achievement tests was higher than in that of tests two and four. Even though it could not be ignored it would be impossible to categorically state that the time difference did, or did not have an impact on the difference in the level of significance of the results. It is the opinion of the researcher that the difference in starting time was not a contributing factor in the fluctuating results. The slight possibility that the change in starting time may have had an effect on the results, indicates that the external confounding variable identified for the study concerning time as specified in 3.5.2, should have been more strictly adhered to, to prevent this uncertainty.

It is, however, the opinion of the researcher that the main reason for the difference between the mean change of tests one and three, and two and four lies in the content and the nature of the outcomes tested in the different tests. The nature of the content included in each test was based on the outcomes covered in the two preceding face-to-face sessions.

Because of the process based method[4] of the curriculum as mentioned in 1.1, the content in test one consisted mainly of factual information based on embedded knowledge of mechanics as seen in Appendix J. This information is largely based on memorisation and does not require much insight or reflection. To answer these questions surface learning was thus sufficient.

Test two required progression on the basic knowledge obtained and tested in test one. Application of the basic mechanical concepts was asked as seen in

Appendix K, requiring reasoning and insight that is only possible if deep learning took place.

As seen in Table 4.4 there was not a marked difference between the mean pre- achievement-test scores of tests one (68.51%) and two (66.62%). This slight decrease in average is in line with the increase in difficulty of the content according to the curriculum.

There was however a bigger difference in the post-achievement-test scores with a lower positive change recorded for the second test (1.98%) in comparison to the first test (11.01%). These results imply that some reflection and higher order processing of information took place during and after the face-to-face session.

The distribution of the mean change in test two indicates a positive change in scores in the majority of participants as reflected in Figure 4.4. It could thus be deduced that a small amount of deep learning took place for the majority of the participants during the intervention session.

A similar pattern is observed in tests three and four. The difference here is that the lowest mean score for any of the pre-achievement–test is seen in test three (47.66%), as indicated in table 4.4.

This lower pre-test mean-score for test three could possibly be ascribed to the fact that this test was based on newly acquired knowledge as seen in Appendix L. The basic concepts related to the human body were learnt in the first half of the year in Anatomy classes. Additional knowledge as applicable to Biomechanics was added to this newly acquired knowledge and tested in test three. The short term retention of the learning that took place during the preceding two face–to-face sessions was thus less than that measured in test one. The exposure to the newly acquired knowledge in the intervention session refreshed the surface knowledge resulting in a high positive mean-change between the pre-and-post-achievement-tests (10.32%).

Test four showed a higher mean score in the pre-achievement-test (53.94%) than that of test three (47.66%). This implies that similar to test two some deep learning took place during the preceding two face-to-face sessions. The mean-change in the fourth achievement test was small at 1.62%. This is similar to the change in test two (1.98%). More application of knowledge was required in tests two and four.

Once again the distribution of the mean change as reflected in Figure 4.4 showed a higher distribution of improvement in the majority of the participants. A small amount of deep learning thus took place during the intervention session.

The difference in the nature of the questions could thus possibly explain the bigger margin of change measured in tests one (11.01%) and three (10.32%) indicating that the use of the interactive *'Basic Biomechanics for therapists'* CD does effectively stimulate surface learning. The decreased change in tests two (1.98%) and four (1.62%) could be ascribed to a lack of stimulation of deep learning by the interactive *'Basic Biomechanics for therapists'* CD. The fact that the intervention session was probably too short for true reflection and processing of the information should be considered.

A deep approach to learning may thus be possible if sufficient time to study the interactive *'Basic Biomechanics for therapists'* CD could be allowed but, it is not as effective when limited time is allowed.

Minimal changes between the pre-achievement-test scores of tests one and two, and tests three and four indicated that some deep learning took place. Svidén's[38] findings, as mentioned in 2.2.3, that occupational therapy students tend to rely mostly on surface learning could thus not be fully agreed with.

Even though the same instructional methods were used in the design of the "Know" and "How" sections of the CD there are some differences in the manner that the different learning proponents are addressed. The section on the "How" differs form the "Know" section in that it offers more 'active'

interaction and requires more 'sensing' and 'reflective' integration of knowledge. Achievement tests 2 and 4 relied more on the content of this "How" section of the CD. Another factor related to the use of the CD is that obtaining the information to answer the questions in achievement tests 2 and 4 required a more extensive use of both the sections of the CD. This difference in the extent and nature of the information needed may have had an impact on the scores achieved.

The results of this study indicate that some deep learning did take place but sufficient time needs to be allowed for the processing of information that is required for deep learning. The principle propounded by Lazear[49] and Felder et al[8], as discussed in 2.5.4, that information should be gathered over a period of time to elicit higher order thinking is thus confirmed. The short time allowed during the intervention for this study was insufficient for true deep learning, and could thus not provide a conclusive answer to the effectiveness of the interactive '*Basic Biomechanics for therapists*' CD to stimulate deep learning.

Even though the extent of deep learning was not determined by this study it must be remembered that in view of the learning requirements of occupational therapy students as discussed in 2.2.3, deep learning is important. Deep learning is identified as imperative for the continued growth required to become and remain efficient occupational therapists. Deep learning should thus be stimulated as much as possible in the education of occupational therapy students to cultivate good habits.

Based on the results of this study it could thus be concluded that even though significant improvement in achievement was measured with a t- score of 0.00, the stimulation of deeper learning seems to be limited. This may be ascribed to the limited time allowed to study the intervention tool and further investigation of this important aspect of learning should be done.

5.2.3 Objective Three

Will the first year occupational therapy students studying at the University of Pretoria experience the use of the interactive 'Basic Biomechanics for therapists' CD as positive or negative?

According to the studies done by Cameron[24] and Davies et al[21] as seen in 2.7, there is not yet consensus on the acceptability of the use of e-learning for occupational therapy students.

As indicated in the study done by Cameron[24] the background of the students in the form of exposure to computers may play a role in how comfortable the students are in the use of this tool. The possible diverse backgrounds of the occupational therapy students studying at the University of Pretoria may coincide with this finding of Cameron.[24] The sample group for this study did however not include any students from poor rural areas. In spite of this lack of inclusion of students from poor rural areas it is still possible that students that lacked computer exposure may have been part of the sample group. The use of computers may thus not be equally familiar to all the participants to this study. The extent of exposure to computers was not determined and could thus not be commented on.

The results reflected in Table 4.7 indicate the frequency distribution of the replies to each of the 10 questions. It also includes the possible association between the replies to the survey questions for tests 1-4. Significant association was determined by the Fisher's exact. Only questions three and ten indicated that there is not a significant association between the results for the four tests. Question one indicated a marginal significant association.

The lack of significance of these two questions may have been explained by the delay in starting time for the third survey as explained in 3.6. A negative attitude may have been reflected. Marked changes in the scores are observed in questions one, seven and ten where the scores dropped by more

than five between the second and third tests. In all three these questions the scores improved again in test four by at least 2%. The lack of significant association between the four tests could thus possibly be explained by this delay.

Only the questions where weak or no significant association or other differences were indicated will be further analysed.

Question one focussed on the ease of navigation in the use of the interactive CD. Results indicated that the first section needed for test one was regarded as easy. A slight gradual increase of negative replies indicates that the ability to find the information required became more complex. The nature of the interactive *'Basic Biomechanics for therapists'* CD is such that information becomes more integrated when application of the outcomes is explained. The tests also required good retention of knowledge of outcomes tested previously. If this knowledge was not in place, more navigation between different sections of the interactive *'Basic Biomechanics for therapists'* CD was required thus increasing the amount of navigation required.

Question three dealt with the better understanding of the outcomes studied. The percentage difference between the positive and negative responses fluctuated between tests. The lowest score being that for test three. A sharp drop in positive responses is observed in the second test from 60 to 45 with more decreases in positive replies in tests three and four. This decline in satisfaction may be related to the complexity of the applied questions. In test two the outcomes are applied to real life situations for the first time as seen in Appendix K. The extent of application of knowledge is increased. This increase in the demand for application may result in some uncertainty in the participants because different scenarios to that used in the CD are often expected. The association between the tests for this question indicate no significance.

Question five was the only question that dealt with the inclusion of an auditory element to the interactive 'Basic Biomechanics for therapists' CD. The replies to this question were found to be mostly negative. Test two indicated a slightly higher positive answer but significant association between the tests was still identified.

Question ten dealt with the preference to use computer based learning. Similar to question three there was a sharp drop in positive responses associated with tests two to four. The association between the tests and the replies were found to be not significant. The same fluctuation in the responses from test-to-test could be seen in this question as that to question three. The more negative or positive responses may be closely linked to the ease to understand the content. The clarity of the content should be re-examined. This may result in a more positive attitude towards the use of the interactive *'Basic Biomechanics for therapists'* CD.

Familiarity and ease of use of a computer was not determined. It may be a factor that may play a bigger role in future as the diversity of the occupational therapy students at the University of Pretoria increase and further investigation should thus be done.

In view of the constant improvement in the reliability coefficient, this fluctuation between test-results indicated that some of the content in the CD were experienced as being easier understood than others. There was a drop in positive responses in tests three and four. This phenomenon will need to be investigated further to identify possible changes to the interactive *'Basic Biomechanics for therapists'* CD.

Improvement of the computer skills of the occupational therapy students may also contribute to a more positive attitude to the use of the interactive *'Basic Biomechanics for therapists'* CD.

5.2.4 Objective four

Will this interactive 'Basic Biomechanics for therapists' CD have an effect on learning Biomechanics by the first year occupational *therapy students studying at the University of Pretoria, based on their learning styles?*

Significant relationships were identified between all the learning proponents and the changes in achievement in all the tests. The weakest relationships were found with the 'verbal', 'intuitive' and 'global' proponents

In examining how these relationships were accommodated by the CD it was found that the proponents were represented as follows:

- The 'active' learning proponent was found to be strongly related to the changes in the achievement of tests one and three. Active learning is accommodated by the many interactive elements where choices could be made by the user as to what and how the interaction took place.

  The less significant relationships in tests two and four are in line with the findings on the changes in achievement. It identifies an area where more interactivity that challenges the user to apply the basic concepts, might improve the interactive *'Basic Biomechanics for therapists'* CD.

- The relationship between the 'reflective' proponent and the different tests showed a similar relationship to the first test as that of the 'active' proponent. The second and fourth tests, however, indicate a very weak relationship that may indicate that not enough reflection is included. As discussed in the primary question this may be regarded as an area where possible change to the interactive *'Basic Biomechanics for therapists'* CD should be considered.

- Significant relationships with the 'sequential' proponent could also be identified. Tests one and three showed strong relationships, whereas tests two and four indicated less strong relationships.
  The content of the interactive *'Basic Biomechanics for therapists'* CD is presented sequentially. The more applied content is close to the end of each section implying that the user needs more time to benefit from this application if the resource is used in a sequential manner. If the CD is thus done sequentially the user will only reap the benefit once the whole section has been completed.

- The 'global' learner could approach the interactive 'Basic Biomechanics for therapists' CD in a different order by selecting the applied sections first and thus determining if the outcomes are sufficiently understood. The interactive *'Basic Biomechanics for therapists'* CD remains inherently a more sequential orientated tool. This is confirmed in the results of the relationship between the 'global' learning proponent and the change in achievement. The only test that indicates a strong relationship to the 'global' proponent is the first test. The other three tests all indicate only a weak relationship.

- The 'sensing' proponent showed similar relationships to those of the 'visual' proponent. Tests one and three being strong and two and four weaker. The 'sensing' proponent was accommodated by the inclusion of real life situations that could be visualised. Questions based on these real life situations had to be answered. The student thus had to depend on external information that was provided, to be able to respond to the questions.

- The 'visual' proponent showed a slightly weaker but still significant relationship to the changes in achievement than the other three identified proponents for the learning style profile of the sample group.

Most of the information included in the interactive *'Basic Biomechanics for therapists'* CD is 'verbal' even if not auditive. It is supplemented by 'visual' elements like videos, photos, sketches, and animations. These visual elements included in the resource added to the need for visual learning. The use of even more visual elements may improve the resource.

- The 'intuitive' and 'verbal' proponents indicated a negative relationship to the achievement in tests three and four. This indicates that the interactive *'Basic Biomechanics for therapists'* CD does not accommodate these two proponents effectively for the purpose of applied or deep learning.

  The concrete nature of the outcomes does not lend itself to intuitive learning. It would thus be difficult to include this learning proponent effectively in the interactive *'Basic Biomechanics for therapists'* CD.

  The inclusion of an audio element to the CD, was rejected by 60% of participants. This relates to the more 'visual' learning style proponent identified in this group. The balance of 40% of the sample group does not only represent the 16% 'verbal' learners but also a percentage of 'visual' learners. This fact may require further consideration especially in the development of other similar resources for different modules.

The most significant relationships were observed for the 'active', 'sensing', 'visual' and 'sequential' proponents. This indicates that the intention of providing the first year occupational therapy students studying at the University of Pretoria with more 'active' and 'visual' learning was achieved.

5.3 Limitations of the study

Limitations relevant to the study were present in different aspects of the study.

The first limitation being the method in which the study had to be conducted. Different methods were considered. A comparative study may have provided stronger results. However, this would have required dividing the sample group in two with one group having access to the CD. This scenario could not ethically be justified so it had to be rejected. A second option that was considered was making use of students at two different universities. The technical ability to ensure that the same exposure to the outcomes and pre-knowledge, especially Anatomy, was the same would have been almost impossible to control leading to the rejection of such an option as well.

Measurement instruments: Possible limitations in the reliability of the measurement tool for achievement testing were suggested in the pilot study. Even though the achievement test was found to be statistically reliable in the pilot study it was suggested in 3.4.4 that there still may have been limitations to the clinical significance. However, the clinical significance was confirmed by the results of the study thus the reliability of the achievement test could be accepted.

Possible limitations concerning the pre- and post-achievement tests could be perceived in the fact that these tests were set by the researcher and developer of the learning resource. Even though questions were gathered from different resources they could still have been influenced by the teaching style of the researcher. Questions set by different educators in the field of Biomechanics may have provided a wider range of questions but not necessarily a different result.

The experience survey was limited to ten questions. A survey question on the participant's exposure to e-learning and computers in particular may also

have assisted in determining the reason why the question on preference to using a computer for learning was not more conclusive.

5.4 Main conclusions

Due to the fact that the change in the achievement of the participants complied with the required significance level of t>0.05, the null hypothesis could be rejected. It was thus proven that the interactive 'Basic Biomechanics for therapists' CD had a significant positive effect on the learning of the sample group.

A learning style profile was established for the first year occupational therapy students studying at the University of Pretoria. The same four learning style proponents namely 'active', 'sensing', 'visual' and 'sequential' were identified in the research and pilot studies. The learning style profile confirmed that the assumed 'visual' proponent is dominant.

Because of the fact that the learning profiles identified in the research and the pilot study are similar, a conclusion could be made that this learning style profile is representative of the larger population of occupational therapy students studying at the University of Pretoria.

Relationships between the different learning style proponents and the achievement were analysed. The results of the 'active', 'sensing', 'visual' and 'sequential' proponents were found to have the strongest relationships to the positive changes in achievement.

It could thus be concluded that the interactive '*Basic Biomechanics for therapists*' CD contributed positively to the learning of Biomechanics and it successfully accommodated the learning-styles of the first year occupational therapy students studying at the University of Pretoria

Some concern regarding the suitability of the interactive '*Basic Biomechanics for therapists'* CD is still present in the seemingly limited stimulation of deeper learning as only eight of the ten experience survey questions indicated a significant relationship between the four tests and the questions. The inclusion of more strategies to stimulate deep learning should be considered to further improve this interactive multimedia resource.

5.5 Recommendations for implementation

The results of the study identified some areas of concern that are still present. To ensure that the interactive '*Basic Biomechanics for therapists'* CD maximally benefits the intended users, there are still some areas that may need consideration. Recommendations based on the results and the areas of concern will now be discussed.

5.5.1 E-Learning:

In view of the increasing demand for e-learning as discussed in 2.6, the interactive '*Basic Biomechanics for therapists'* CD may serve as a guide for the development of other similar e-learning methods to be used in the Occupational therapy Department at the University of Pretoria. The results of this study should thus be discussed and made available to other staff members for use in their respective modules.

Careful consideration should be given to the content and the interactivity of the e-learning tool to ensure 'active' involvement of the students. This is confirmed by previous studies done by Cameron[24] and Davies et al[21] and should be heeded. The development of interactive multimedia resources is

very costly and time consuming. It is therefore important that well researched information should be utilised to ensure maximum value is obtained.

Effectiveness of the CD: Even though the interactive *'Basic Biomechanics for therapists'* CD was found to be effective in improving the achievement of the participants, some areas that could still be improved upon were identified.

Stimulation of applied/deep learning should be improved: It should be considered to improve the application of information in the interactive *'Basic Biomechanics for therapists'* CD. It may improve the seemingly insufficient stimulation of deep learning and thus benefit the users. Not all users will benefit because the choice of interaction with the information still depends on the individual. Possible strategies that may be applied could include the inclusion of case studies to be solved. More deep learning may also be present if more time for reflection on the information available in the interactive 'Basic Biomechanics for therapists' CD is allowed.

Improving the understanding of the outcomes: Question three of the survey indicated that there is still room for improvement. A careful analysis of the information provided in the interactive *'Basic Biomechanics for therapists'* CD should be done. Areas where information transmission could be improved should be identified and changed accordingly.

Reassessment of the 'visual' and 'verbal' input of the interactive 'Basic Biomechanics for therapists' CD: More 'visual' learning could be included in the interactive *'Basic Biomechanics for therapists'* CD. Consideration was given to the 'verbal' content of the resource being strengthened by the addition of a voice recording. This auditive addition was however rejected by the results of the study.

Improved acceptability of e-learning: The indication that the interactive *'Basic Biomechanics for therapists'* CD will be used by the students is still not conclusively proven. Consistent to the studies done as described in the literature in 2.7 there are still some occupational therapy students that are

more reluctant than others to make use of e-learning.[24] The results of this study indicate that 70% of the participants would use the interactive *'Basic Biomechanics for therapists'* CD in future.

The researcher is of the opinion that for the foreseeable future there will be uncertainty of this preference in the South African context. The disparity in exposure to computers in schools will take at least another generation if not more to be equalised between students from poorer rural areas and urban based students. Resolving this disparity will be the only way to increase the computer literacy of all students to the extent that students do not feel threatened or at a disadvantage when required to use e-learning.

The continual training in computer literacy by the University of Pretoria should be in step with the needs of the individual students. Even though the computer literacy was not measured, it was observed by the researcher that, although, many of the participants are adept in the use of mobile electronic communication devices this does not necessarily include the use of computer based electronic media for learning. It may be of value to do a further study to confirm or reject these observations.

The availability of the interactive *'Basic Biomechanics for therapists'* CD should be carefully considered. Unlike a printed book it is much easier to copy, or downloads a CD. It may be to the advantage of the students and other researchers if the interactive 'Basic Biomechanics for therapists' CD is made available on the intranet or even on the web site of the University of Pretoria. This will allow for on-going academic interaction and inputs that can be taken into consideration prior to any revisions to the existing interactive multimedia resource.

5.5.2 Learning-styles

In view of the findings of this study it may be assumed that the learning profile as determined in this study is generalizable to the occupational therapy students studying at the University of Pretoria. This profile can thus be used as guideline in the planning of other e-learning and face-to-face teaching of these occupational therapy students.

It is however recommended that learning style tests are done with each new group of first year occupational therapy students to obtain a continuous profile. Changes in the biographical profile of the occupational therapy students in future may lead to a change in the learning style profile.

5.6 Suggestions for further research

A few aspects that may add value if studied in more depth were identified in this study.

As discussed in 2.3 the background differences between the occupational therapy students studying at the University of Pretoria may impact on their learning. A study on the effect of these differences may assist lecturers in providing more applicable education to students from different backgrounds. Due to the need to include more students from different cultures and socio-economic backgrounds, the demographics of the occupational therapy students studying at the University of Pretoria are bound to change in the near future.

The need to stimulate applied or deep learning in occupational therapy students was emphasised in 2.2.3. Based on the lower mean change

between the pre- and post-achievement-tests in tests two and four, it would be of value to determine if and to what extent the interactive *'Basic Biomechanics for therapists'* CD stimulates deep learning.

A study on what effect computer literacy may have on the experience of students using e-learning may provide answers to the questions posed as to why some students do not feel comfortable using such a resource. It may provide guidelines to enhance the computer training already provided to students to bridge the perceived gap between them.

5.7 Conclusion:

The ever changing technology and thus the learning needs of the occupational therapy students that grew up during y-generation era should be understood and accommodated. The reality of the increasing need for e-learning should be recognised and appropriately addressed. The differing backgrounds of these occupational therapy students should however be borne in mind in order to accommodate the needs of all the students.

Future development of e-learning is inevitable. Continued research to improve the use of this medium for teaching and learning should thus be encouraged.

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APPENDIX A: OUTCOMES FOR BIOMECHANICS

Topic	Embedded knowledge	Outcomes
Levers and forces	Know the structure, muscles and nerve supply of the upper limb.	*Levers* Be able to define and explain the three classes of levers. Apply the mechanical and mathematical process of determining mechanical advantage Be able to deduct the applicable lever system to joints in the body and understand its advantage to the body's functioning. Understand how the neuro-musculoskeletal system of the body, the execution of an activity or an adaptation to equipment can overcome mechanical disadvantage (rotary equilibrium). *Forces* Normal forces: Compressive, tensile (and elasticity): Be able to apply Newton's laws of mechanics to certain movements. Force Magnitude and orientation: Understand the concept of forces along the same line. Understand how to find the resultant of forces along the same line. Understand the concept of force combinations. Understand how to find the resultant of force combinations. Understand a force diagram. *Torque* Understand the concept of torque.

Topic	Embedded knowledge	Outcomes
		Be able to apply the concept of torque to objects and to the body. *Rotational forces* Understand and be able to explain the difference between linear and rotary motion. Understand the concept of rotary motion. Understand and be able to explain the concept of rotary motion. Understand and be able to explain the characteristics of rotary motion. Understand the concept of the optimal angle of force application to obtain rotary motion. Understand rotary equilibrium (balanced lever system).
Axes, planes and curves	Anatomy of vertebral column	Anatomical axes and planes Be able to define the axes of the body. Be able to describe the three anatomical axes around which movement takes place: - Vertical Axis. - Lateral Axis. - Anterior-posterior axis. Be able to define the planes of the body. Be able to describe the three anatomical planes the body is divided into: - Horizontal Plane. - Frontal Plane. - Sagital Plane. Know the orientation of the axis in relation to the planes.

Topic	Embedded knowledge	Outcomes
		Know the definition of a functional movement and a pure anatomical movement. *Vertebral curves* Be able to describe the normal vertebral curves. Be able to describe the three pathological curves: Lordosis. Kyphosis. Scoliosis. Be able to do an abbreviated evaluation of posture. Be able to assess posture by using a plumb line. Be able to describe an anterior and posterior pelvic tilt.
Muscles	Know the structure, muscles and nerve supply of the upper and lower limb.	*Muscles* Be able to explain the various types of muscles according to their structure and type of function. Muscle work/activity Be able to name the muscles in all movements round each joint of the limbs. Be able to describe the following types of muscle activity: Isometric contraction. Isotonic contraction: concentric or eccentric. Agonist. Antagonist. Synergist.

Topic	Embedded knowledge	Outcomes
		Be able to analyse the various types of muscle activity used in movement, especially as applied to the upper limb. Know and be able to explain concentric and eccentric muscle work or activity. *Muscle force and excursion* Bulk/girth Fibre Length and Muscle Length Resting Length [120% of resting length is optimal for muscle tension Excursion Know the factors that influences muscle force. Understand muscle excursion. Understand that muscle tension/force relates to muscle/fibre length. *Muscle power* Be able to explain how gravity and resistance influences muscles strength. Be able to explain how muscle strength is measured. Know the Oxford scale for measuring muscle strength as well as it's adaptations. *Multi-joint muscles* *Be able to name the multi-joint muscles in the body, with the emphasis on the Upper Limb.* *A multi-joint muscle produces movement at more than one joint. It moves one or more joints at a time through full range of motion'* Understand Active Insufficiency.

Topic	Embedded knowledge	Outcomes
		Active insufficiency describes a situation in which excursion of the muscle is too short and therefore cannot move all it's joints' Understand Passive Insufficiency. Passive insufficiency restricts movement in the opposite direction because the muscle is too short to permit full movement' Know the joint positions in which multi-joint muscles are fully stretched or shortened. *Kinematic chains* Know the difference between open and closed kinematic chains Know the characteristics of an open kinematic chain movement. Know the characteristics of an closed kinematic chain movement. Be able to analyse movement and classify it according to kinematic chains.
The hand	Know the various types of muscle activity. Know the structure, muscles and nerve supply of the upper limb	*Arches of the hand* Understand why the hand needs arches to be functional. Know the arches of the hand: *Hand grasps* Know the classification of adult hand grasps: Be able to explain the role of the Intrinsic Hand Muscles in grasp. Be able to analyse the intrinsic negative hand *Tenodesis grasp* Know the principle of a tenodesis grasp.

Topic	Embedded knowledge	Outcomes
		Know how an internal / external tenodesis grasp could be obtained. Be able to explain why some patients would require a tenodesis grasp.

APPENDIX B: BASIC BIOMECHANICS FOR THERAPISTS CD

Basic Biomechanics for Therapists CD in attached sleeve

APPENDIX C: INDEX OF LEARNING STYLES (ILS) TEST

NC STATE UNIVERSITY

Index of Learning Styles Questionnaire

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Richard M. Felder
Department of Chemical Engineering
North Carolina State University
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Top of Form

Directions

Please provide us with your full name. Your name will be printed on the information that is returned to you.

Four digit number

For each of the 44 questions below select either "a" or "b" to indicate your

answer. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently. When you are finished selecting answers to each question please select the submit button at the end of the form.

I understand something better after I

- **(a)** try it out.
- **(b)** think it through.

I would rather be considered

- **(a)** realistic.
- **(b)** innovative.

When I think about what I did yesterday, I am most likely to get

- **(a)** a picture.
- **(b)** words.

I tend to

- **(a)** understand details of a subject but may be fuzzy about its overall structure.
- **(b)** understand the overall structure but may be fuzzy about details.

When I am learning something new, it helps me to

- **(a)** talk about it.
- **(b)** think about it.

If I were a teacher, I would rather teach a course

- **(a)** that deals with facts and real life situations.

- **(b)** that deals with ideas and theories.

I prefer to get new information in

- **(a)** pictures, diagrams, graphs, or maps.
- **(b)** written directions or verbal information.

Once I understand

- **(a)** all the parts, I understand the whole thing.
- **(b)** the whole thing, I see how the parts fit.

In a study group working on difficult material, I am more likely to

- **(a)** jump in and contribute ideas.
- **(b)** sit back and listen.

I find it easier

- **(a)** to learn facts.
- **(b)** to learn concepts.

In a book with lots of pictures and charts, I am likely to

- **(a)** look over the pictures and charts carefully.
- **(b)** focus on the written text.

When I solve math problems

- **(a)** I usually work my way to the solutions one step at a time.
- **(b)** I often just see the solutions but then have to struggle to figure out the steps to get to them.

In classes I have taken

- **(a)** I have usually gotten to know many of the students.
- **(b)** I have rarely gotten to know many of the students.

In reading non-fiction, I prefer

- **(a)** something that teaches me new facts or tells me how to do something.
- **(b)** something that gives me new ideas to think about.

I like teachers

- **(a)** who put a lot of diagrams on the board.
- **(b)** who spend a lot of time explaining.

When I'm analyzing a story or a novel

- **(a)** I think of the incidents and try to put them together to figure out the themes.
- **(b)** I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

When I start a homework problem, I am more likely to

- **(a)** start working on the solution immediately.
- **(b)** try to fully understand the problem first.

I prefer the idea of

- **(a)** certainty.
- **(b)** theory.

I remember best

- **(a)** what I see.
- **(b)** what I hear.

It is more important to me that an instructor

- **(a)** lay out the material in clear sequential steps.

- **(b)** give me an overall picture and relate the material to other modules.

I prefer to study

- **(a)** in a study group.
- **(b)** alone.

I am more likely to be considered

- **(a)** careful about the details of my work.
- **(b)** creative about how to do my work.

When I get directions to a new place, I prefer

- **(a)** a map.
- **(b)** written instructions.

I learn

- **(a)** at a fairly regular pace. If I study hard, I'll "get it."
- **(b)** in fits and starts. I'll be totally confused and then suddenly it all "clicks."

I would rather first

- **(a)** try things out.
- **(b)** think about how I'm going to do it.

When I am reading for enjoyment, I like writers to

- **(a)** clearly say what they mean.
- **(b)** say things in creative, interesting ways.

When I see a diagram or sketch in class, I am most likely to remember

- **(a)** the picture.
- **(b)** what the instructor said about it.

When considering a body of information, I am more likely to

- **(a)** focus on details and miss the big picture.
- **(b)** try to understand the big picture before getting into the details.

I more easily remember

- **(a)** something I have done.
- **(b)** something I have thought a lot about.

When I have to perform a task, I prefer to

- **(a)** master one way of doing it.
- **(b)** come up with new ways of doing it.

When someone is showing me data, I prefer

- **(a)** charts or graphs.
- **(b)** text summarizing the results.

When writing a paper, I am more likely to

- **(a)** work on (think about or write) the beginning of the paper and progress forward.
- **(b)** work on (think about or write) different parts of the paper and then order them.

When I have to work on a group project, I first want to

- **(a)** have "group brainstorming" where everyone contributes ideas.
- **(b)** brainstorm individually and then come together as a group to compare ideas.

I consider it higher praise to call someone

- **(a)** sensible.
- **(b)** imaginative.

When I meet people at a party, I am more likely to remember

- **(a)** what they looked like.
- **(b)** what they said about themselves.

When I am learning a new subject, I prefer to

- **(a)** stay focused on that subject, learning as much about it as I can.
- **(b)** try to make connections between that subject and related modules.

I am more likely to be considered

- **(a)** outgoing.
- **(b)** reserved.

I prefer courses that emphasize

- **(a)** concrete material (facts, data).
- **(b)** abstract material (concepts, theories).

For entertainment, I would rather

- **(a)** watch television.
- **(b)** read a book.

Some teachers start their lectures with an outline of what they will cover. Such outlines are

- **(a)** somewhat helpful to me.
- **(b)** very helpful to me.

The idea of doing homework in groups, with one grade for the entire group,

- **(a)** appeals to me.
- **(b)** does not appeal to me.

When I am doing long calculations,

- **(a)** I tend to repeat all my steps and check my work carefully.
- **(b)** I find checking my work tiresome and have to force myself to do it.

I tend to picture places I have been

- **(a)** easily and fairly accurately.
- **(b)** with difficulty and without much detail.

When solving problems in a group, I would be more likely to

- **(a)** think of the steps in the solution process.
- **(b)** think of possible consequences or applications of the solution in a wide range of areas.

When you have completed filling out the above form please click on the Submit button below. Your results will be returned to you. If you are not satisfied with your answers above please click on Reset to clear the form.

Submit Reset

Bottom of Form

APPENDIX D: FELDER-SOLOMAN ILS TEST RESULTS

Example of how the ILS test results are reflected

Results for: xxx

ACT **X** REF

11 9 7 5 3 1 1 3 5 7 9 11

<-- -->

SEN **X** INT

11 9 7 5 3 1 1 3 5 7 9 11

<-- -->

VIS **X** VRB

11 9 7 5 3 1 1 3 5 7 9 11

<-- -->

SEQ **X** GLO

11 9 7 5 3 1 1 3 5 7 9 11

<-- -->

ANNEXURE E: INFORMED CONSENT FORM FOR PILOT STUDY

BACKGROUND INFORMATION:

I am studying to obtain my masters degree in occupational therapy at the department of occupational therapy at the University of Pretoria. You are invited to volunteer to participate in our research project

TITLE OF THE STUDY:

THE EVALUATION OF AN INTERACTIVE MULTIMEDIA LEARNING RESOURCE BASED ON THE LEARNING STYLES OF FIRST YEAR OCCUPATIONAL THERAPY STUDENTS

This leaflet gives you information to help you to decide if you are willing to take part in this research. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask us. You should not agree to take part unless you are completely happy about what we expect of you.

The purpose of the study is to determine if an interactive learning resource (multimedia) that was developed for biomechanics which is part of aku 100 in the second half of the year will be compatible to all the learning- styles of first year occupational therapy students.

The research ethics committee of the University of Pretoria and faculty of health sciences granted written approval for this study.

In your first year you completed learning style tests, a computer based quiz and a short survey on your experience using the cd.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. The identity of the participants will remain anonymous. Therefore, you will not be identified as a participant in any publication that comes from this study.

PLEASE SIGN THE ATTACHED CONSENT FORM TO ACKNOWLEDGE RECEIPT OF THIS INFORMATION LEAFLET.

We sincerely appreciate your help.

YOURS TRULY,

ELSJE RUDMAN

STUDENTS / PARTICIPANT'S1 INFORMATION LEAFLET & INFORMED

CONSENT FOR ANONYMOUS QUESTIONNAIRES

Researcher's name: Elsje Rudman

Student number: 21151556

Department of Occupational Therapy

University of Pretoria

Protocol number: S163/2009

Dear Participant / Student /

Please make sure you read the information leaflet before signing this form. Please sign this form if you agree to take part in the study as explained in the information leaflet.

You received all the information and take part in all the aspects of the pilot study.

I hereby consent to take part in the research as explained in the information leaflet.

Name: _____

Student number: _____

APPENDIX F: LEARNING STYLES AND STRATEGIES

Richard M. Felder
Hoechst Celanese Professor of Chemical Engineering
North Carolina State University

Barbara A. Soloman
Coordinator of Advising, First Year College
North Carolina State University

ACTIVE AND REFLECTIVE LEARNERS

- Active learners tend to retain and understand information best by doing something active with it--discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first.
- "Let's try it out and see how it works" is an active learner's phrase; "Let's think it through first" is the reflective learner's response.
- Active learners tend to like group work more than reflective learners, who prefer working alone.
- Sitting through lectures without getting to do anything physical but take notes is hard for both learning types, but particularly hard for active learners.

Everybody is active sometimes and reflective sometimes. Your preference for one category or the other may be strong, moderate, or mild. A balance of the two is desirable. If you always act before reflecting you can jump into things prematurely and get into trouble, while if you spend too much time reflecting you may never get anything done.

How can active learners help themselves?

If you are an active learner in a class that allows little or no class time for discussion or problem-solving activities, you should try to compensate for these lacks when you study. Study in a group in which the members take turns explaining different topics to each other. Work with others to guess what you will be asked on the next test and figure out how you will answer. You will always retain information better if you find ways to do something with it.

How can reflective learners help themselves?

If you are a reflective learner in a class that allows little or no class time for thinking about new information, you should try to compensate for this lack when you study. Don't simply read or memorize the material; stop periodically to review what you have read and to think of possible questions or applications. You might find it helpful to write short summaries of readings or class notes in your own words. Doing so may take extra time but will enable you to retain the material more effectively.

SENSING AND INTUITIVE LEARNERS

- Sensing learners tend to like learning facts, intuitive learners often prefer discovering possibilities and relationships.
- Sensors often like solving problems by well-established methods and dislike complications and surprises; intuitors like innovation and dislike repetition. Sensors are more likely than intuitors to resent being tested on material that has not been explicitly covered in class.
- Sensors tend to be patient with details and good at memorizing facts and doing hands-on (laboratory) work; intuitors may be better at grasping new concepts and are often more comfortable than sensors with abstractions and mathematical formulations.
- Sensors tend to be more practical and careful than intuitors; intuitors tend to work faster and to be more innovative than sensors.

- Sensors don't like courses that have no apparent connection to the real world; intuitors don't like "plug-and-chug" courses that involve a lot of memorization and routine calculations.

Everybody is sensing sometimes and intuitive sometimes. Your preference for one or the other may be strong, moderate, or mild. To be effective as a learner and problem solver, you need to be able to function both ways. If you overemphasize intuition, you may miss important details or make careless mistakes in calculations or hands-on work; if you overemphasize sensing, you may rely too much on memorization and familiar methods and not concentrate enough on understanding and innovative thinking.

How can sensing learners help themselves?

Sensors remember and understand information best if they can see how it connects to the real world. If you are in a class where most of the material is abstract and theoretical, you may have difficulty. Ask your instructor for specific examples of concepts and procedures, and find out how the concepts apply in practice. If the teacher does not provide enough specifics, try to find some in your course text or other references or by brainstorming with friends or classmates.

How can intuitive learners help themselves?

Many college lecture classes are aimed at intuitors. However, if you are an intuitor and you happen to be in a class that deals primarily with memorization and rote substitution in formulas, you may have trouble with boredom. Ask your instructor for interpretations or theories that link the facts, or try to find the connections yourself. You may also be prone to careless mistakes on test because you are impatient with details and don't like repetition (as in checking your completed solutions). Take time to read the entire question before you start answering and be sure to check your results

VISUAL AND VERBAL LEARNERS

Visual learners remember best what they see--pictures, diagrams, flow charts, time lines, films, and demonstrations. Verbal learners get more out of words--written and spoken explanations. Everyone learns more when information is presented both visually and verbally.

In most college classes very little visual information is presented: students mainly listen to lectures and read material written on chalkboards and in textbooks and hand-outs. Unfortunately, most people are visual learners, which mean that most students do not get nearly as much as they would if more visual presentation were used in class. Good learners are capable of processing information presented either visually or verbally.

How can visual learners help themselves?

If you are a visual learner, try to find diagrams, sketches, schematics, photographs, flow charts, or any other visual representation of course material that is predominantly verbal. Ask your instructor, consult reference books, and see if any videotapes or CD-ROM displays of the course material are available. Prepare a concept map by listing key points, enclosing them in boxes or circles, and drawing lines with arrows between concepts to show connections. Color-code your notes with a highlighter so that everything relating to one topic is the same color.

How can verbal learners help themselves?

Write summaries or outlines of course material in your own words. Working in groups can be particularly effective: you gain understanding of material by hearing classmates' explanations and you learn even more when you do the explaining.

SEQUENTIAL AND GLOBAL LEARNERS

- Sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it."
- Sequential learners tend to follow logical stepwise paths in finding solutions; global learners may be able to solve complex problems quickly or put things together in novel ways once they have grasped the big picture, but they may have difficulty explaining how they did it.

Many people who read this description may conclude incorrectly that they are global, since everyone has experienced bewilderment followed by a sudden flash of understanding. What makes you global or not is what happens before the light bulb goes on. Sequential learners may not fully understand the material but they can nevertheless do something with it (like solve the homework problems or pass the test) since the pieces they have absorbed are logically connected. Strongly global learners who lack good sequential thinking abilities, on the other hand, may have serious difficulties until they have the big picture. Even after they have it, they may be fuzzy about the details of the subject, while sequential learners may know a lot about specific aspects of a subject but may have trouble relating them to different aspects of the same subject or to different modules.

How can sequential learners help themselves?

Most college courses are taught in a sequential manner. However, if you are a sequential learner and you have an instructor who jumps around from topic to topic or skips steps, you may have difficulty following and remembering. Ask the instructor to fill in the skipped steps, or fill them in yourself by consulting references. When you are studying, take the time to outline the lecture material for yourself in logical order. In the long run doing so will save

you time. You might also try to strengthen your global thinking skills by relating each new topic you study to things you already know. The more you can do so, the deeper your understanding of the topic is likely to be.

APPENDIX G: MULTIPLE CHOICE TEST FOR PILOT STUDY

Student number: _____

Date: _____

Researchers name: Mrs Elsje Rudman

Occupational Therapy Department

University of Pretoria

Dear student,

Please complete the following questionnaire. The questionnaire should take about 10 minutes to complete.

The information is anonymous and will not have any impact on your marks for the course.

Your participation in this study is voluntary. You may refuse to participate and stop at any time without giving a reason.

We sincerely appreciate your help.

Yours truly

Mrs Elsje Rudman

Code used for programming of all achievement tests:

? – Question

@ - Possible answer

@+ - Correct answer

Please indicate with an X the appropriate correct answer.

?A force can be defined as: (select one)

'n Krag kan gedefinïeer word as: (kies een)

@+Force = Mass x Acceleration

Krag = Massa x Versnelling

@Force = Mass/Acceleration

Krag = Massa/Versnelling

@Force = Mass + Acceleration

Krag = Massa + Versnelling

?Define a lever system (select one)

Definïeer 'n hefboomstelsel (kies een)

@An object moving in a circle

'n Objek wat in 'n sirkel beweeg

@+A rigid structure that pivots at a fixed point

‘n Rigide struktuur wat om ‘n vaste punt

@A force applied in a linear manner

‘n Krag wat liniêr toegepas word

?Resistive forces are: (select one)

Weerstands kragte is (kies een)

@+Any force that opposes another force

Enige krag wat ‘n ander krag teenstaan

@Forces that initiate motion

Kragte wat beweging inisïeer

@Forces the result in acceleration

Kragte wat versnelling tot gevolg het

?Friction acts as: (select one)

Wrywing tree op as ‘n: (kies een)

@An activating force

‘n Aktiverende krag

@+A resistive force

‘n Weerstandskrag

@A stabilising force

‘n Stabiliserende krag

?The magnitude of a force is measured in: (select one)

Die groote van ‘n krag word gemeet in: (kies een)

@Meters

@+Vectors/Vektors

@Centimeters/Sentimeters

?The force exerted by the blades of the scissors is known as: (select one)

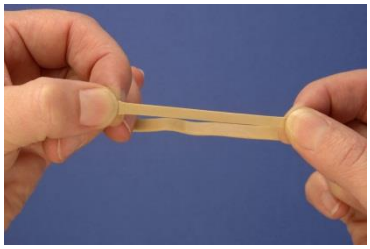
Die krag wat deur die lemme van die skêr uitgeoefen word, staan bekend as: (kies een)

@Stress/Stres

@Friction/Wrywing

@+Shear force/Skuifkrag

?The effect of force application illustrated in this image is: (select one)



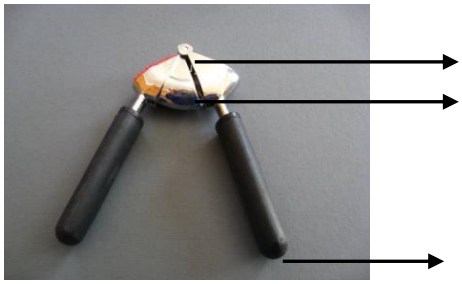
@+Distraction/distraksie

@Compression/Kompressie

@Torque/Wringkrag

?Indicate which of the following will form the resistance arm on this object: (select one)

Dui aan watter van die volgende sal die weerstandsarm vorm: (kies een)



@+ Between the top/axis and the middle lines

Tussen die boonste en midelste lyne

@ Between the middle and the botom lines

Tussen die midelste en onderste lyne

@Between the bottom and top lines

Tussen die onderste en midelste lyne

?The axis is: (select one)

Die as is: (kies een)

@The point where the force is applied

Die punt waar die krag toegepas word

@+The point around which rotation takes place

Die punt waarom rotasie plassvind

@The point where the resistance is applied

Die punt waar die weerstand toegepas word

?Mechanical advantage is defined as: (select one)

Meganiese voordells word gedefinieer as: (kies een)

@MA = Force X Resistance

MA = Krag X Weerstand

@+MA = Force / Resistance

MA = Krag / Weerstand

@MA = Resitance / Force

MA = Weerstand / Krag

?Identify the lever system that is used with this object (select one)

Identifiseer die hefboomstelsel wat in hierdie voorwerp gebriuk word: (kies een)

@+Type 1/Tipe 1

@Type 2/Tipe 2

@Type 3/Tipe 3

?Identify the lever system that is used by this object:: (select one)

Identifiseer die hefboomstelsel wat in hierdie voorwerp gebriuk word: (kies een)

@+Type 1/Tipe 1

@Type 2/Tipe 2

@Type 3/Tipe 3

?Rotational force is measured in what unit: (select one)

Rotasiekrag word gemeet in watter eenheid: (kies een)

@Vectors

@+Radians

@Meters

?Torque is the amount of force exerted when: (select one)

Wringkrag is die hoeveelheid krag wat toegepas word wanneer: (kies een)

@linear motion takes place

Liniere beweging plaasvind

@+rotation takes place

Rotasie plaasvind

@displacement takes place

Verplasing plaasvind

?Torque is increased when the force is applied: (select one)

Wringkrag word vermeerder wanneer die krag : (kies een)

@Closer to the axis

Nader aan die as toegepas word

@At the axis

By die as toegepas word

@+Further away from the axis

Verder van die as af toegepas word

?Mechanical advantage is achieved when the force arm (select one)

Meganiese voordeel word verkry wanneer die krag arm: (kies een)

@is the same length as the resistance arm

Dieselfde lengte is as die weerstandsarm

@is shorter than the resistance arm

Korter is as die weerstandsarm

@+is longer than the resistance arm

Langer is as die weerstandsarm

?When displacement takes place the force is known as a (select one)

Wanneer verplasing plaavind staan die krag bekend as ‘n: (kies een)

@Resistive force/weerstandskrag

@+Translational force/verplasingskrag

@Shear force/skeurkrag

?An activating force changes the: (select one)

‘n Aktiveringskrag verander die: (kies een)

@+Inertia of an object

Traagheid van ‘n voorwerp

@Acceleration of an object

Versnelling van ‘n voorwerp

@Centre of gravity of an object

Gravitasiepunt van ‘n voorwerp

?The Centre of gravity of an object is determined by: (select one)

Die gravitasiepunt van ‘n voorwerp word bepaal deur: kies een)

@The distribution of weight

Die gewigsverspreiding

@+The distribution of mass

Die verspreiding van die massa

@The shape of an object

Die vorm van die voorwerp

?Weight is: (select one)

Gewig is: (kies een)

@+Mass and gravity

Massa en gravitasie

@Matter and gravity

Materie en gravitasie

@Mass and matter

Massa en materie

?Line of gravity is the line from: (select one)

Die gravitasie lyn is die lyn vanaf: (kies een)

@The top of an object to the ground

Die hoogste punt van die voorwerp tot by die grond

@The base of an object to the ground

Die basis van ondersteuning tot by die grond

@+The centre of gravity to the ground

Die gravitasiepunt tot by die grond

?An angular force may be measured with (select one)

'n skuins krag kan gemeet word met: (kies een)

@A vector/'n vektor

@+A paralellogram/paralellogram

@A ruler/liniaal

?Applying a force in a straight line to the base of an object will result in moving the object in a: (select one)

Wanneer 'n krag in 'n reguit lyn by die basis ban 'n voorwerp aangewend word sal die voorwerp beweeg in 'n: (kies een)

@+Linear direction

Reguit lyn

@Rotational motion

In 'n sirkel

@Angular motion

In 'n skuins lyn

?Gravitational force is determined by (select one)

Gravitasie krag word bepaal deur: (kies een)

@The distance from the ground

Die afstand van die grond af

@The mass of an object

Die massa van die voorwerp

@+Remains constant

Bly konstant

?The application of force will result in more damage when the area of force application is: (select one)

Wanneer ‘n krag toegepas wor op ‘n oppervlak sal die effek van die krag meer skade aanrig wanneer die area waaroor die krag versprei word: (kies een)

@+Smaller

Kleiner is

@Larger

Groter is

@The area makes no difference

Die area sal geen verskil maak nie

?Friction will be increased when: (select one)

Wrywing sal vermeerder wanneer: (kies een)

@The surface is denser

Die oppervlak digter is

@The surface is softer

Die oppervlak sagter is

@The surface is lubricated

Die oppervlak gesmeer is

?Force has a: (select one)

Krag het 'n: (kies een)

@+Magnitude, direction, point of application

Grote, rigting en aanwendingspunt

@Magnitude, direction,dimension

Grote, rigting en omvang

@Motion, magnitude, point of application

Beweging, omvang en aanwendingspunt

?A lever arm is: (select one)

'n Hefboom arm is: (kies een)

@+The portion of a lever between the resistance/force and the axis

Die gedeelte van die hefboom tussen die weerstand/krag en die as

@The length of a rotating object

Die lengte van die roterende voorwerp

@The portion between the applied force and the resistance

Die gedeelte tissen die aangewende krag en die weerstand

?An example of a type 3 lever system is(select one)

'n Voorbeeld van 'n tipe 3 hefboom is: (kies een)

@Force-Axis-Resistance

Krag-As-Weerstand

@+Axis-Force-Resistance

As-Krag-Weerstand

@Axis-Resitance-Force

As-Weerstand-krag

?The deformation in this object is known as: (select one)

Dei vervorming in die voorwerp staan bekend as: (kies een)

@+Compression/kompressie

@Distraction/distraksie

@Friction/wrywing

APPENDIX H: EXPERIENCE SURVEY

Evaluation of the experience of the use of the "Basic biomechanics for therapists" interactive CD

Student number: _____

Date: _____

Researchers name: Mrs Elsje Rudman

Occupational Therapy Department

University of Pretoria

Dear student,

Please complete the following questionnaire to indicate your experience in using the interactive e-learning CD you have just been exposed to. The questionnaire should take about 10 minutes to complete.

The information is anonymous and will not have any impact on your marks for the course.

Your participation in this study is voluntary. You may refuse to participate and stop at any time without giving a reason.

We sincerely appreciate your help.

Yours truly

Mrs Elsje Rudman

Please indicate your answers with an X in the indicated spaces.

Key: 1. Strongly disagree

2. Disagree

3. Neutral

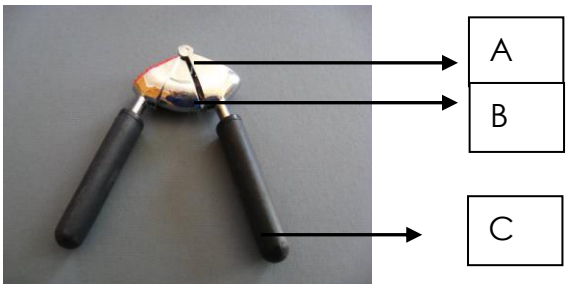
4. Agree

5. Strongly agree

Questions	1	2	3	4	5
I found the navigation of the CD easy.					
It is easy to find the meaning of terms.					
The session enhanced my understanding of the topic					
The examples that are used to illustrate the concepts increased my understanding					
I would like an auditory element added to the CD					
The information is presented clearly					
The level of information is correct for me					
I like the fact that I can control what information I look at e.g. movies					
The questions at the end of the section helped me to identify gaps in my knowledge.					
I enjoy using a computer in this manner as a learning tool.					

APPENDIX I: ACHIEVEMENT TEST 1

-Content area	Knows	Comprehends
Levers	?Identify the type three lever system: (select one) *Identifiseer die tipe drie hefboom stelsel: (kies een)* @force-axis-resistance *krag-as-weerstand* @+axis-force-resistance *as-krag-weerstand* @axis-resitance-force *as-weerstand-krag* ?A description of a lever arm is: (select one) *'n Beskrywing van 'n hefboomarm is: (kies een)* @the length of a rotating object *die lengte van 'n roterende voorwerp* @the portion between the applied force and the resistance *die gedeelte tussen die aangewende krag en die*	?Identify the lever system that is used in this object: (select one) *Identifiseer die hefboomstelsel wat in hierdie voorwerp aangewend word: (kies een)*  @+type 1 *tipe 1* @type 2 *tipe 2* @type 3 *tipe 3* ?Identify the lever system that is used with this object: (select one) *Identifiseer die hefboomstelsel wat in hierdie voorwerp aangewend word: (kies een)* 

-Content area	Knows	Comprehends
	weerstand @+the portion of a lever between the resistance/force and the axis *die gedeelte van'n hefboom tussen die weerstand/krag en die as* ?In a lever system the axis is: (select one) *Die as in 'n hefboomstelsel is: (kies een)* @the point where the force is applied *die punt waar die krag toegepas word* @+the point around which rotation takes place *die punt waarom rotasie plaasvind* @the point where the resistance is applied *die punt waar die weerstand toegepas word*	@+type 1 *tipe 1* @type 2 *tipe 2* @type 3 *tipe 3* ?Indicate which of the following forms the resistance arm on this object: (select one) *Dui aan watter van die volgende sal die weerstandsarm vorm: (kies een)*  @+ AB @ BC @AC
Forces	?Friction is regarded as: (select one)	?The force exerted by the blades of the scissors is known as: (select one)

-Content area	Knows	Comprehends
	Wrywing word beskou as: (kies een) @an activating force *'n aktiverende krag* @+a resistive force *'n weerstandskrag* @a stabilising force *'n stabiliserende krag* ?The formula to define force is: (select one) *Die formule wat 'n krag definieer is: (kies een)* @+Force = Mass x Acceleration *Krag = Massa x Versnelling* @Force = Mass/Acceleration *Krag = Massa/Versnelling* @Force = Mass + Acceleration *Krag = Massa + Versnelling* ?The magnitude of a force is measured in:	*Die krag wat deur die lemme van die skêr uitgeoefen word, staan bekend as: (kies een)* @stress *stres* @friction *wrywing* @+shear force *skeurkrag* ?The nature of the surface will increase friction when: (select one) *Die aard van die oppervlak sal die wrywing vermeerder wanneer: (kies een)* @the surface is denser *die oppervlak digter is* @+the surface is softer *die oppervlak sagter is* @the surface is lubricated *die oppervlak gesmeer is* ?Resistive forces are: (select one) *Weerstandskragte is: (kies een)* @+any force that opposes another force *enige krag wat 'n ander krag teenstaan* @forces that initiate motion

-Content area	Knows	Comprehends
	(select one) *Die groote van 'n krag word gemeet in: (kies een)* @meters *meters* @+vectors *vektors* @centimeters *sentimeters*	*kragte wat beweging aan die gang sit* @forces that result in acceleration *kragte wat versnelling tot gevolg het*
Application of force	?Mechanical advantage is defined as: (select one) *Meganiese voordeel word gedefinieer as: (kies een)* @MA = Force X Resistance *MA = Krag X Weerstand* @+MA = Force / Resistance *MA = Krag / Weerstand* @MA = Resitance / Force *MA = Weerstand / Krag* ?Torque is the amount of force exerted when: (select one)	?Mechanical advantage is achieved when the force arm: (select one) *Meganiese voordeel word verkry wanneer die krag arm: (kies een)* @is the same length as the resistance arm *dieselfde lengte is as die weerstandsarm* @is shorter than the resistance arm *korter is as die weerstandsarm* @+is longer than the resistance arm *langer is as die weerstandsarm* ?Torque is increased when the force is applied: (select one) *Wringkrag word vermeerder wanneer die krag : (kies een)* @closer to the axis

-Content area	Knows	Comprehends
	Wringkrag is die hoeveelheid krag wat toegepas word wanneer: (kies een) @linear motion takes place *liniêre beweging plaasvind* @+rotation takes place *rotasie plaasvind* @displacement takes place *verplasing plaasvind* ?A force that is applied at an angle to the object will result in (select one) *'n Krag wat teen 'n hoek teenoor 'n objek toegepas word sal die volgende veroorsaak (kies een)* @+rotational or angular motion *rotasie of skuins beweging* @angular or straight motion *Skuinsof reguit beweging*	*nader aan die as toegepas word* @at the axis *by die as toegepas word* @+further away from the axis *verder van die as af toegepas word* ?Applying a force in a straight line to the base of an object will result in moving the object in a: (select one) *Wanneer 'n krag in 'n reguit lyn op die basis van 'n voorwerp aangewend word, sal die voorwerp beweeg in 'n: (kies een)* @+linear direction *liniêre rigting* @ circular direction *sirkulêre rigting* @angular direction *skuins rigting*

-Content area	Knows	Comprehends
	@motion in a straight line or rotation *beweging in 'n reguit lyn of rotasie*	
Basic concepts	?Rotational force is measured in which unit: (select one) *Rotasiekrag word gemeet in watter eenheid: (kies een)* @vectors *vektors* @+radians *radiale* @meters *meters* ?Weight is a combination of: (select one) *Gewig is 'n kombinasie van: (kies een)* @+mass and gravity *massa en gravitasie* @matter and gravity *materie en gravitasie* @mass and matter	?The application of force on a surface will result in more damage when the area of force application is: (select one) *Wanneer 'n krag toegepas word op 'n oppervlak sal die effek van die krag meer skade aanrig wanneer die area waaroor die krag versprei word: (kies een)* @larger *groter is* @+smaller *kleiner is* ?An angular force may be measured with: (select one) *'n Skuins krag kan gemeet word met: (kies een)* @a vector *'n vektor* @+a paralellogram 'n *paralellogram* @a ruler 'n *liniaal* ?The deformation in this object is known as: (select one) *Die vervorming in hierdie voorwerp staan bekend as: (kies*

-Content area	Knows	Comprehends
	massa en materie ?Gravitational force is determined by: (select one) *Gravitasie krag word bepaal deur: (kies een)* @the distance from the ground *die afstand van die grond af* @the mass of an object *die massa van die voorwerp* @+the pulling force of the earth that remains constant *die aantrekkingskrag van die aarde wat konstant bly*	*een)*  @+compression *kompressie* @distraction *distraksie* @friction *wrywing*
Laws of Newton	?The definition of the second law of Newton: (select one) *Die definisie van die tweede wet van Newton: (kies een)* @body continues in a state of rest or uniform	?An activating force changes the: (select one) *'n Aktiveringskrag verander die: (kies een)* @+Inertia of an object *traagheid van 'n voorwerp* @acceleration of an object

-Content area	Knows	Comprehends
	motion unless an unbalanced force acts on it *'n liggaam is in 'n toestand van uniforme beweging tensy 'n ongeballanseerde krag daarop uitgeoeffen word* @+the acceleration of an object is directly proportional to the force causing it *die versnelling van 'n voorwerp is proporsioneel tot die krag wat dit veroorsaak* @for every action there is an equal and opposite reaction *vir elke aksie is daar 'n gelyke teenoorgestelde reaksie* ?If a car rolls down an incline it will accelerate. Choose the correct formula that will measure this acceleration: (select one) *'nvvoertuig wat teen 'n afdraende afrol sal versnel. Kies die korrekte formule wat hierdie*	*versnelling van 'n voorwerp* @centre of gravity of an object *gravitasiepunt van 'n voorwerp* ?A car crashes into a wall. What force of Newton is applicable in the passenger in the car flying through the windscreen: (select one) *'n Kar bots teen 'n muur. Watter wet van Newton is van toepassing op die passasier wat deur die windskem vlieg: (kies een)* @ +first law *eerste wet* @second law *tweede wet* @third law *derde wet* ?The force that is exerted by a table to keep a book supported is defined by which law of Newton: (select one) *Deur watter wet van Newton word die krag wat deur 'n tafel uitgeoeffen word om 'n boek te ondersteun gedeffinieer: (kies een)* @ first law *eerste wet* @second law *tweede wet*

-Content area	Knows	Comprehends
	versnelling sal meet: (kies een) @Acceleration=Force x Mass *Versnelling=Krag x Massa* @+Acceleration=Force / Mass *Versnelling= Krag / Massa* @Acceleration=Mass / Force *Versnelling=Massa / Krag* ?The inertia of an object that is spinning will be increased when the distribution of the body weight is: (choose one) *Die traagheid van 'n voorwerp wat in die rondte tol sal verbeter wanneer die verspreiding van die liggammsgewig:.(kies een)* @bigger *groter is* @+smaller	@+third law *derde wet*

-Content area	Knows	Comprehends
	kleiner is @evenly distributed *eweredig versprei is*	

APPENDIX J: ACHIEVEMENT TEST 2

-Content area	Knows	Comprehends
Base of support	?Base of support is defined as: (select one) *Basis van ondersteuning word gedeffinieer as: (kies een)* @all points of contact with the ground and the area in between *al die punte van kontak met die grond en die area tussenin* @all points of contact with the ground *al die punte in kontak met die grond* @+all points of contact with the supporting surface and the area in between *al die punte van kontak met die ondersteunende oppervlakte en die area tussenin* ? A..... base of support will provide better stability for a taller object: (select one) *'n ..... basis van ondersteuning sal beter stabiliteit vir 'n langer voorwerp verleen: (kies een)* @smaller *kleiner*	?T and S are playing in the sandpit. T is sitting down on his haunches and S is standing on his hands and knees. The base support of S will be formed by the: (select one) *T en S speel in die sandpit. T sit op sy hurke en S is hande viervoet. S se basis van ondersteuning sal bestaan uit: (kies een)* @+contact of his hands, knees and feet and the area in between *die kontak van sy hande , knieë en voete en die area tussenin* @contact of his feet and knees and the area in between *kontak van sy voete en knieë en die area tussenin* @contact of his knees and hands and the area in between *kontak van sy knieë en hande en die area tussenin* ?The soccer player is kicking a ball with his right foot. Identify the base of support during the kicking action: (select one) *Die sokkerspeler skop die bal met sy regte*

-Content area	Knows	Comprehends
	@+bigger *groter* @the same *dieselfde* ?Stability will be increased if the base of support is: (select one) *Stabiliteit sal verbeter word as die basis van ondersteuning: (kies een)* @smaller than the width of the object *kleiner is as die wydte van die voorwerp* @+bigger than the width of the object *groter is as die wydte van die voorwerp* @the same as the width of the object *dieselfde is as die wydte van die voorwerp*	*voet. Identifiseer sy basis van ondersteuning tydens hierdie aksie: (kies een)* @the point of contact of his right foot *die kontak punt van sy regtervoet* @+the point of contact of his left foot *die punt van kontak van sy linkervoet* @the area between his two feet *die area tussen die twee voete* ?P is tilting his wheelchair onto the back wheels. What forms the base of support of the wheelchair: (select one) *P kantel sy rolstoel op die agterwiele: Wat sal die basis van ondersteuning vir die rolstoel wees: (kies een)* @contact area of the two back wheels of the wheelchair *kontak area van die twee agterwiele van die rolstoel* @+contact area and the area in between the two back wheels *kontak area en die area tussen die twee agterwiele van die rolstoel* @contact area of all four the wheels of the wheelchair *kontak area van al vier die wiele van die rolstoel* @contact area and the four wheels and

-Content area	Knows	Comprehends
		the area in between the wheels. *kontak area van die vier wiele en die area tussen die vier wiele*
Centre of gravity	?Define centre of gravity: (select one) *Definieer gravitasie punt: (kies een)* @+the balancing point of an object *die balanseringspunt van 'n voorwerp* @the centre of an object *die middel van 'n voorwerp* @the widest point of an object *die wydste punt van 'n voorwerp* ?The centre of gravity of an object is determined by: (select one) Die gravitasiepunt van 'n voorwerp word bepaal deur: (kies een) @+the distribution of mass *die verspreiding van die massa* @the distribution of weight *die gewigsverspreiding* @the shape of an object *die vorm van die voorwerp* ?The centre of gravity is important for; (select one) *Die gravitasie punt is belangrik vir; (kies*	?An object is more stable when the centre of gravity is: (select one) *'n Voorwerp is meer stabiel wanneer die gravitasie punt: (kies een)* @further away from the base of support *verder van die basis van ondersteuning is* @+closer to the base of support *nader aan die basis van ondersteuning is* @outside the base of support *buite die basis van ondersteuning* @in the middle of the base of support *in die middel van die basis van ondersteuning is* ?Why does a cricket player lean his body to the opposite side of his swinging arms and the bat when he hits the ball: (select one) *Hoekom leun die krieketspeler sy liggaam in die teenoorgestelde rigting as die arms wat die kolf swaai wanneer hy 'n bal slaan: (kies een)* @he needs to shift his centre of gravity to the side of the swinging arms

-Content area	Knows	Comprehends
	een) @+balance *balans* @equilibrium *ewewig* @movement *Beweging*	*hy moet die gravitasiepunt in die rigting van sy swaaiende arms skuif* @he needs to lower his centre of gravity *hy moet sy gravitasiepunt laer skuif* @+he needs to shift his centre of gravity away from his swinging arms *hy moet die gravitasiepunt weg van sy swaaiende arms skuif* @he needs to shift his centre of gravity higher *hy moet die gravitasie punt hoër skuif* ?When a person lifts one arm the centre of gravity will: (select one) *Wanner 'n persoon sy een arm oplig sal sy gravitasiepunt: (kies een)* @+move to the same side as the lifted arm *skuif na dieselfde kant as die opgeligte arm* @ move to the opposite side to the lifted arm *skuif na die teenoorgestelde kant as die opgeligte arm* @remain in the centre of the body *in die middel van die liggaam bly*
Line of	?Line of gravity is: (select one)	?F is walking with a walking stick. She leans on her walking stick when she has to take

-Content area	Knows	Comprehends
gravity	*Die gravitasielyn is: (kies een)* @+a perpendicular line from the centre of gravity of the object to the ground *'n loodregte lyn vanaf die gravitasiepunt van die voorwerp tot by die grond* @a perpendicular line from the widest point of the object to the ground *'n loodregte lyn vanaf die wydste punt van die voorwerp tot by die grond* @a perpendicular line from the centre of the object to the ground. *'n loodregte lyn van die middel van die voorwerp tot by die grond* ?To ensure good balance the line of gravity should fall: (select one) *Om goeie balans te verseker moet die gravitasie lyn: (kies een)* @outside the base of support *buite die basis van ondersteuning val* @in line with the centre of gravity *in lyn met die gravitasie punt val* @+inside the base of support *binne die basis van ondersteuning val*	weight on her weak leg. Where will her line of gravity be when leaning on her stick: (select one) *F loop met 'n kierie. Sy leun op haar kierie wanneer sy moet gewig dra op haar swak been. Waar sal haar gravitasiepunt wees terwyl sy op die kierie leun: (kies een)* @+on the same side as the stick *aan dieselfde kant as die kierie* @on the opposite side to the stick *aan die teenoorgestelde kant as die kierie* @at the centre of her body *in die middel van haar liggaam* ?A lady is carrying a bucket of water on her head. In order to balance the bucket she must ensure that; (select one) *'n Vrou dra 'n emmer water op haar kop. Om die emmer te balanseer moet sy verseker dat: (kies een)* @+the line of gravity remains inside the base of support *die gravitasielyn binne die basis van ondersteuning bly* @the centre of gravity remains inside the base of support *die gravitasiepunt in die basis van ondersteuning bly*

-Content area	Knows	Comprehends
	?The line of gravity changes position with the centre of gravity: (select one) *Die gravitasie lyn verander posisie saam met die gravitasie punt: (kies een)* @+true *waar* @false *fals*	@the line of gravity remains in line with the head *die gravitasielyn in lyn met haar kop bly* ?Stability is increased when the line of gravity is: (select one) *Stabiliteit is beter wanneer die gravitasielyn: (kies een)* @to the front of the base of support *aan die voorkant van die basis van ondersteuning is* @to the back of the base of support *aan die agterkant van die basis van ondersteuning is* @+in the middle of the base of support *in die middel van die basis van ondersteuning is*
Balance and equilibrium	?To achieve a state of equilibrium an object should be supported: (select one) *Om ewewig te bereik moet 'n voorwerp ondersteun word: (kies een)* @directly below the centre of the object *direk onder die middel van die voorwerp* @+directly below the centre of gravity of the object *direk onder die gravitasiepunt van die voorwerp*	?The dancer stands on her toes with her arms in an arc above her head. What effect does the position of her arms have on her balance: (select one) *Die danser staan op haar tone met haar arms in 'n boog bokant haar kop. Watter effek sal die posisie van haar arms op haar balans hê: (kies een)* @it will improve her balance because her centre of gravity will move up *dit sal haar balans verbeter omdat haar gravitasie pun sal opskuif*

-Content area	Knows	Comprehends
	@over a bigger area *oor 'n groot area* ?Balance is achieved when two parts have; (select one) *Balans word bereik wanneer twee dele: (kies een)* @the same size *dieselfde groote het* @the same shape *dieselfde vorm het* @+the same mass *dieselfde massa het* ?Factors that influence the balance of an objects are: (select one) *Faktore wat die balans van 'n voorwerp beinvloed is: (kies een)* @base of support, height of centre of gravity and size *basis van ondersteuning, hoogte van gravitasiepunt en grootte* @base of support, height of centre of gravity and mass *basis van ondersteuning, hoogte van gravitasiepunt en massa* @height of centre of gravity, mass and	@it will improve her balance because her base of support will be enlarged *dit sal haar balans verbeter omdat dit haar basis van ondersteuning sal vergroot* @+it will improve her balance because it will spread her weight evenly to both sides of her base of support. *dit sal haar balans verbeter omdat dit haar gewig eweredig sal versprei aan beide kante van haar basis van ondersteuning* ?A child is building a tower with blocks. The tower will balance easier if: (select one) *'n Kind bou 'n toring met blokkies. Die toring sal makliker balanseer as: (kies een)* @+the blocks are all the same size and weight *die blokkies almal ewe groot en swaar is* @the blocks are different size and weight *die blokkies almal verskillende grootes en gewig het* @the blocks are all the same size with different weight *die blokkies almal dieselfde groote en verskillend in gewig is* ?Two children are riding on a see-saw. The effectiveness of the ride will be the best if:

-Content area	Knows	Comprehends
	size *hoogte van gravitasiepunt, groote en massa*	(select one) *Twee kinders ry op 'n wipplank. Die aksie van die wipplank sal meer effektief wees as: (kies een)* @the children are the same size *die kinders dieselfde grootte het* @+the two children are the same weight *die twee kinders dieselfde weeg* @the children push harder off the ground to make the see-saw move *die kinders harder wegskop van die grond af om die wipplank te laat beweeg*
Posture	?An old lady is walking with a hunched posture. What is this posture known as: (select one) *'n Ou dame loop met 'n geboë postuur. As wat staan hierdie postuur bekend:(kies een)* @+kyphosis *kifose* @lordosis *lordose* @scoliosis *skoliose* The man's left leg is shorter than the right.	?M is carrying a heavy book bag over her left shoulder. What effect will this have on her posture: (select one) *M dra 'n swaar boeksak oor haar linker skouer. Watter effek sal dit op haar postuur hê: (kies een)* @+lateral curvature of the thorasic spine to the left *laterale kurwe van die torakale werwels na links* @lateral curvature of the thorasic spine to the right *laterale kurwe van die torakale werwels na regs* @posterior curvature of the thorasic spine

-Content area	Knows	Comprehends
	What effect will it have on his posture: (select one) *Die man se linker been is korter as sy regter been. Watter effek sal dit op sy postuur hê: (kies een)* @result in lordosis *lordose veroorsaak* @+result in scoliosis *skoliose veroorsaak* @result in kyphosis *kifose veroorsaak* When a person is sitting on his haunches the lumbar curve of his spine will be: (select one) *Wanneer 'n persoon op sy hurke sit sal sy lumbale kurwe: (kies een)* @increased *vergroot* @+flattened *afgeplat wees* @remain the same *dieselfde bly*	*posterior kurwe van die torakale werwels* @anterior curvature of the thorasic spine *anterior kurwe van die torakale werwels* ?When a person looks up the cervical spinal curve is increased, what would the effect be on the lower curves of the spine: (select one) *Wanneer 'n persoon opkyk word die servikale kurwe van die nek werwels vermeerder, watter effek sal dit hê op die laer kurwes van die spinaalkolom: (kies een)* @+the curves will flatten out *die kurwes sal afplat* @the curves will increase *die kurwes sal vermeerder* @there will be no change in the curves *die kurwes sal dieselfde bly* ?Sitting in front of a computer with the screen at eye level the posture will be: (select one) *As u voor die rekenaar sit met die skerm op oog hoogte sal die postuur: (kies een)* @an anterior curved posture *'n anterior gekurfde postuur wees*

-Content area	Knows	Comprehends
		@a posterior curved posture *'n posterior gekurfde postuur wees* @+a correct posture *'n korrekte postuur wees*

APPENDIX K: ACHIEVEMENT TEST 3

-Content area	Knows	Comprehends
Upper limb function 3/5	?The collective name for hook, spherical, cylindrical and lumbrical grips is: (select one) *Die kollektiewe naam vir die hak,silindriese, sferiese, en lumbrikale grepe is (kies een):* @precision grip *presissie greep* @+power grip *kraggreep* @prehension grip *prehensiegreep* ?A two point prehension grip is when: *'n Tweepunt prehensiegreep is wanneer:* @+the index and thumb tips are used *die indeks en duim tippies gebruik word* @the side of the index and thumb tip are used *die kant van die indeks en tip van die duim word gebruik* @the index , middle finger and thumb tips are used	?S is holding a cup in her hand. She grips the ear of the cup with her index and middle finger while the cup is resting on her ring finger. What type of grip is she using in her index and middle fingers: (select one) *S hou 'n koppie in haar hand. Sy hou die oor van die koppie in haar indeks en middel vingers vas terwyl die koppie op haar ring vinger rus. Watter tipe greep gebruik sy in haar indeks en middel vinger: (kies een)* @lumbrical grip/*lumbrikale greep* @+hook grip *hakgreep* @spherical grip *sferiesegreep* @cylindrical grip *silindriesegreep* ?What type of grip is used when holding a needle to do sewing on a button: (select one) *Watter tipe greep word gebruik om 'n naald vas te hou wanneer 'n knoop*

-Content area	Knows	Comprehends
	die indeks, middelvinger en tip van die duim word gebruik ?In order to perform a cylindrical grip you need the function of: (select one) *Vir die gebruik van 'n silindirese greep is die funksie van.....nodig: (kies een)* @+Flexor Policus Longus and Flexor Digitorum Profundus *Fleksor Polisis Longus en Fleksor Digitorum Profundus* @Extensor Policus Longus and Flexor Digitorum Profundus *Ekstensor Polisis Longus en Fleksor Digitorum Profundus* @Flexor Digitorum Superficialis and Flexor Digitorum Profundus *Fleksor Digitorum Superfisialis en Fleksor Digitorum Profundus* ?Retraction of the scapula is a .....motion: (select one) *Retraksie van die scapula is 'n .....beweging: (kies een)* @rotation *rotasie* @+liniar *liniêre*	*aangewerk word; (kies een)* @+two point prehension grip *twee punt prehensiegreep* @three point prehension grip *driepunt prehensiegreep* @lateral prehension grip *laterale prehensiegreep* ? What motion is taking place at his scapula when M is pushing the door closed.: (select one) *Watter beweging vind by die scapula plaas wanneer M die deur toestoot: (kies een)* @ elevation *elevasie* @retraction *retraksie* @+protraction *protraksie* @internal rotation *interne rotasie* ?What motion takes place at the fore arm when using a screwdriver to undo a screw: (select one)

-Content area	Knows	Comprehends
	@angular *skuins* ?What motion takes place at the elbow when lifting a cup from the table: (select one) *Watter beweging vind by die elmboog plaas wanneer 'n koppie opgelig word van die tafel af: (kies een)* @extension *ekstensie* @+flexion *fleksie* @rotation *rotasie*	*Watter beweging vind plaas by die voorarm wanneer 'n skroewedraaier gebruik word om 'n skroef uit te draai: (kies een)* @extension and flexion *ekstensie en fleksie* @+supination and pronation *supinasie en pronasie* @ulnar and radial deviation *ulnêre en radiale dewiasie* ?The policeman is directing the trafic at the crossing. What motions take place at his shoulder when he signals the trafic to stop: (select one) *Die polisieman reguleer die verkeer by die kruising. Watter bewegings vind by sy skouergewrig plaas wanneer hy aandui dat die verkeer moet stop: (kies een)* @adduction ans internal rotation *Adduksie en interne rotasie* @abduction and internal rotation *abduksie en interne rotasie* @adduction and external rotation *adduksie en eksterne rotasie* @+abduction and external rotation *abduksie en eksterne rotasie*

-Content area	Knows	Comprehends
Plane of motion Chains of motion 2/3	?Rotation of the spine takes place on the ….. plane of motion: (select one) *Rotasie van die werwelkolom vind plaas op die …. vlak van beweging: (kies een)* @sagital *saggitale* @frontal *frontale* @+horizontal *horisontale* ?Shoulder flexion and extension takes place on the sagital plane of motion. Around what axis does these motions take place: (select one) *Skouer fleksie en ekstensie vind op die sagitale vlak van beweging plaas. Om watter as vind hierdie bewegings plaas: (kies een)* @+lateral axis *laterale as* @anterior posterior axis *anterior posterior as* @vertical axis *wertikale as* ?What chain of motion is used when	?T is eating soup. Identify the plane of motion that elbow motion is taking place on during this action: (select one) *T eet sop. Identifiseer die vlak van beweging wat deur die elmboog beweging gebruik word tydens hierdie aksie: (kies een)* @+sagital plane *saggitale vlak* @frontal plane *frontale vlak* @horizontal plane *horisontale vlak* ?P is kicking a ball with his right foot. On what plane of motion will the hip motion take place: (select one) *P skop 'n bal met sy regter voet. Op watter vlak van beweging sal die heup aksie plaasvind: (kies een)* @+sagital plane *saggitale vlak* @frontal plane *frontale vlak* @horisontal plane *horisontale vlak*

-Content area	Knows	Comprehends
	retraction of the scapulae are done: (select one) *Watter ketting van beweging word gebruik wanneer retraksie van die scapulas gedoen word: (kies een)* @open chain *oop ketting* @+closed chain *geslote ketting* @no chain *geen ketting*	?V is picking up her cup to drink some tea. What chain of motion is she using: (select one) *V tel haar koppie op om tee te drink. Watter ketting van beweging word uitgevoer: (kies een)* @open chain of motion *oop ketting van beweging* @+closed chain of motion *geslote ketting van beweging*
Muscle and Joints and levers 3/5	?The Metacarpal Phalangeal joint is a: (select one) *Die metakarpaal-falangeale gewrig is 'n: (kies een)* @hinge *skarnier* @ball and socket joint *bal en potjie gewrig* @multi axial joint *multiaksiale gewrig* @+bi axial joint *biaksiale gewrig* ?What type of joint is the wrist joint: (select	?What/ type of contraction will take place in the M Triceps when a person doing push ups lowers his body to the ground: (select one) *Watter tipe kontraksie vind in die M Triseps plaas wanneer 'n persoon wat opstote doen sy liggaam laat sak:* @concentric contraction *konsentriese kontraksie* @+eccentric contraction *essentriese kontraksie* @isometric contraction *isometriese kontraksie* ?The elbow is a hinge joint. What joint

-Content area	Knows	Comprehends
	one) *Watter tipe gewrig is die polsgewrig: (kies een)* @hinge *skarnier* @ball and socket joint *bal en potjie gewrig* @+multi axial joint *multiaksiale gewrig* @bi axial joint *biaksiale gewrig* ? When a muscle contracts the tendon moves. What is this amount of movement that takes place called: (select one) *Wanneer 'n spier saamtrek beweeg die tendon. Wat word die hoeveelheid beweging wat plaasvind genome: (kies een)* @+excursion *ekskursie* @contraction *kontraksie* @glide gly	classification is appropriate for this joint; (select one) *Die elmboog is 'n skarnier gewrig. Watter gewrigs klassifikasie is vir hiedie gewrig van toepassing: (kies een)* @synarthrodial *sinartrodiaal* @amarthrodial *amartrodiaal* @+diarthrodial *diartrodiaal* ?Standing on your toes (as shown in the image) results in the application of what type of lever system: (select one) *Wanneer 'n persoon op sy tone staan (soos gedemonstreer in die foto) word watter tipe hefboom stelsel aangewend (kies een)*  @first type lever *eerste tipe hefboom* @+second type lever *tweede tipe hefboom*

-Content area	Knows	Comprehends
	?The muscle that is responsible for performing an action is called the (select one) *Die spier wat verantwoordelik is vir die uitvoer van 'n aksie is die: (kies een)* @antagonist *antagonis* @+agonist *agonis* @stabilizer *stabiliseerder* @co-contractor *kokontraktor*	@third type lever *derde tipe hefboom*
Body function and lower limb 2/3	?Tilting your head sideways (with the ear towards the shoulder) the motion that takes place in the cervical spine will be: (select one) *Wanneer die kop sywaarts gekantel word (met die oor na die skouer) sal die beweging wat in die servikale werwels plaasvind as volg wees: (kies een)* @anterior flexion and rotation *anterior fleksie en rotasie* @+lateral flexion and rotation *laterale fleksie en rotasie* @lateral flexion and no rotation	?P is kicking a ball with his right foot. Identify the muscle group that will act as agonists to maintain his hips on the same level: (select one) *P skop 'n bal met sy regter voet. Identifiseer die heupspiere wat as agoniste sal werk om die heupe op een vlak te handhaaf: (kies een)* @abductors on the right side *abductors aan die regter kant* @adductors on the right side *adductors aan die regter kant* @+abductors on the left side

-Content area	Knows	Comprehends
	laterale fleksie en geen rotasie ?Which muscles contract when lateral flexion of the trunk takes place: (select one) *Watter spiere sal ssamtrek wanneer laterale fleksie van die romp gedoen word: (kies een)* @bilateral trunk flexors *bilaterale romp fleksore* @unilateral trunk flexors *unilaterale romp fleksore* @+unilateral trunk flexors and extensors *Unilaterale romp fleksore en ekstensore* @bilateral trunk flexors and extensors *bilaterale romp fleksore en ekstensore* ?Inversion and eversion of the foot takes place at the: (select one) *Inversie en eversie van die voet vind plaas by die: (kies een)* @ankle joint *enkel gewrig* @metatarsal phalangeal joints *Metatarsaal-falangeale gewrigte* @+interphalangeal joints	*abductors aan die linker kant* @adductors on the left side *adductors aan die linker kant* ?When bending over to pick up an object from the ground the back has to flex. The agonist muscles will be the back: (select one) *Wanneer 'n persoon sy rug flekseer om iets van die grond af op te tel sal die agonis funksie gedoen word deur die rug.: (kies een)* @+extensors *ekstensore* @flexors *fleksore* @rotators *rotators* S finds it difficult to touch his toes when he keeps his knees extended. What is this phenomena known as: (select one) *S vind dit moeilik om sy tone te raak wanneer hy sy kniëe reguit hou. Wat word hierdie verskynsel genoem: (kies een)* @active insufficiency *aktiewe ontoereikendheid*

-Content area	Knows	Comprehends
	interfalangiale gewrigte	@tenodesis *tenodese* @+passive insufficiency *passiewe ontoereikendheid* @muscle hypertention spier *hipertonie* @contractures *kontrakture*

APPENDIX L: ACHIEVEMENT TEST 4

-Content area	Knows	Comprehends
Basic mechanics 2/3	?P is wearing a wrist extension splint. The distal end pushes the hand into extension, the part over the dorsum of the wrist is keeping the wrist down in the splint and the proximal end balances out the downward force of the hand on the splint. What type of lever system is used for this splint: (select one) *P het 'n pols ekstensie spalk aan. Die distale deel druk die hand in ekstensie, die deel oor die pols hou die pols in die spalk en die proksimale gedeelte balanseer die afwaartse krag van die hand op die spalk. Watter tipe hefboom stelsel word vir die spalk gebruik: (kies een)*  @+type one *tipe een* @type two tipe twee	?M and P are riding on a see-saw. M is heavier than P. To balance the see-saw M has to: (select one) *M en P ry op 'n wipplank. M is swaarder as P. Om die wipplank te balanseer moet M: (kies een)* @sit at the furthest point from the axis *op die verste punt van die as af sit* @push harder with her legs *harder wegstoot met haar bene* @+sit closer to the axis *nader aan die as sit* ?While P is balancing on the back wheels of the wheelchair the line of gravity shouldl: (select one) *Terwyl P op die agterwiele van dei rolstoel balanseer moet die gravitasielyn: (kies een) .* @+fall between the two back wheels *tussen die twee agterwieleval*

-Content area	Knows	Comprehends
	@type three tipe drie ?Resistive forces are: (select one) *Weerstands kragte is (kies een)* @+any force that opposes another force *enige krag wat 'n ander krag teenstaan* @forces that initiate motion *kragte wat beweging inisïeer* @forces the result in acceleration *kragte wat versnelling tot gevolg het* ?When displacement takes place the force is known as a (select one) *Wanneer verplasing plaavind staan die krag bekend as 'n: (kies een)* @resistive force *weerstandskrag* @+translational force *verplasingskrag* @shear force *Skeurkrag*	@fall just behind the two back wheels *net agter die twee agterwiele val* @fall just in front of the two back wheels *Net voor die twee agterwiele val* ?The lumberjacks are cutting down a tree with a saw that is moved by two people at a time. The blade gets very hot during this process. What force is causing this build up of heat: (select one) *Die houtkappers is besig om 'n boom aft e saag met 'n saag wat deur twee mense op 'n slag gebruik word. Die lem van die saag word baie warm tydens gebruik. Watter krag veroorsaak die opbou van hitte: (kies een)* @latent energy *Latente energie* @+friction *Wrywing* @shear force *skeurkrag*
Body mechanics 2/3	?Mr P is walking with crutches after he injured his knee. Describe his base of support: (select one). *Mnr. P loop met krukke nadat hy sy knie*	?T is playing in the sandpit. he is sitting down on his haunches. T is quite stable in spite of the relative small base of support formed by the contact of his feet to the

-Content area	Knows	Comprehends
	beseer het. Beskryf sy basis van ondersteuning: (kies een) @the contact area of his crutches and feet and the area around it *Die kontak area van sy krukke en voete en die area rondom* @+the contact areas of his crutches and feet and the area in between *die kontak area van sy krukke en voete en die area tussenin* @the contact area of his feet and the area in between *die kontak area van sy voete en die area tussenin* ?When a pulling force is applied to a lever at more than 90° the force will result (select one) *Wanner 'n trekkrag op 'n hefboom uitgeoeffen word teen 'n hoek groter as 90° sal dit: (kies een)* @compression at the joint *kompressie by die gewrig veroorsaak* @+distraction at the joint *distraksie by die gewrig veroorsaak* @maximal rotation at the joint *maksimale rotasie by die gewrig veroorsaak*	ground. Explain this statement. (select one) *T speel in die sandput. hy sit op sy hurke. T is heel stabiel ten spyte van sy relatief klein basis van ondersteuning wat gevorm word deur die kontak van sy voete met die grond. Verduidelik hierdie stelling (kies een)* @his centre of gravity is situated high up in his body *sy gravitasiepunt is hoog op in sy liggaam* @+his centre of gravity is close to the ground *sy gravitasiepunt is naby die grond* @he has very good balance *hy het goeie balans* ?M is carrying a heavy book bag over her left shoulder. What effect will this have on her centre of gravity (select one) *M dra 'n swaar boeksak oor haar linker skouer. Wat sal die effek op haar gravitasiepunt wees (kies een)* @+it will move upwards and to her left *dit sal op en na links skuif* @it will move downwards and to her left *dit sal af en na links skuif* @it will move upwards and to her right

-Content area	Knows	Comprehends
	?The torso provides stability to the rest of the body to make function possible. What type of muscle contractions should take place to provide this stability (select one) *Die sabiliteit wat deur die romp verleen word maak funksie in die res van die liggaam moontlik. Watter tipe spierkontraksie moet in die rompspiere plaasvind om hierdie stabiliteit te verskaf (kies een)* @+isometric co-contraction *isometriese kokontraksie* @isotonic co- contraction *isotoniese kokontraksie* @eccentric co-contraction *Essentriese kokontraksie*	*dit sal opwaarts en na regs skuif* @it will move downwards and to her right *dit sal af en na regs beweeg* ? The centre of gravity of a golfer will change when he hits the ball to be (select one) *Wanneer 'n golf speler die bal slaan sal sy gravitasiepunt verskuif na (kies een)* @+on the same side as the golf club and his arms *aan dieselfde kant as die golfstok en sy arms* @on the opposite side to the golf club and his arms *aan die teenoorgestelde kant as die golfstok en sy arms* @in the centre of his body regardless of the position of his arms *in die middle van sy liggaam ongeag van die posisie van sy arms* @lower in his body to give him more stability for his swing *laer in sy liggaam om hom meer stabiliteit te gee vir sy swaai*
Upper limb	?What motion takes place at the wrist when a lid is twisted of a big tub of hand lotion (select one) *Watter beweging vind by die pols plaas*	?T is eating soup with a soup spoon.What action takes place at his elbow joint when he brings the spoon up to his mouth (select one)

-Content area	Knows	Comprehends
	wanneer die deksel van 'n groot pot handeroom afgedraai word (kies een) @flexion *fleksie* @extension *ekstensie* @radial deviation *radiale deviasie* @+ulnar deviation *ulnare deviasie* ?A little girl is cutting out pictures with a pair of paper scissors. The action of opening the scissors is done by her thumb muscles. Name the antagonist muscle to this action. (select one) *"n Dogtertjie sny 'n prentjie uit met 'n papierskêr. Om die skêr oop te maak word die duimspieregebruik. Noem die agonistiese spiere vir hierdie aksie (kies een)* @flexor policus longus *fleksor polisis longus* @+extensor policus longus *ekstensor polisis longus* @abductor policus longus *abductor polisis longus*	*T eet sy sop met 'n soplepel. Watter aksie vind by sy elmboog plaas wanneer hy die lepel na sy mond toe bring.(kies een)* @extension @+flexion @supination @pronation ?T is eating soup with a soup spoon. Identify the elbow muscle that will be used as the agonist when the hand is lowered towards the plate.(select one) *T et sop met 'n soplepel. Identifiseer die elmboog agonis wat gebruik sal word wanneer die lepel na die bord toe gesak word. (kies een)* @Triceps Brachi *Triseps Brachi* @+Biceps Brachi *Biseps Brachi* @Anconeus *Ankoneus* @Brachioradialis *Bragioradialis* ?M is brushing her teeth. In what position will her forearm be (select one)

-Content area	Knows	Comprehends
	?M is doing push ups in the gym. What muscles will act as agonists when he pushes up.(select one) *M doen opstote in die gymnasium. Watter spiere sal as agoniste gebruik word wanneer hy himself opstoot (kies een)* @elbow extensors, shoulder flexors, scapula retractors *elmboog ekstensore, skouer fleksore, scapula retraktore* @elbow extensors, shoulder extensors, scapula protractors *elmboog ekstensore, skouer ekstensore, scapula protraktore* @+elbow extensors, shoulder flexors, scapula protractors *elmboog ekstensore, skouer fleksore, scapula protraktore* ?M is brushing her teeth holding the toothbrush in her right hand. Name the position that the shoulder will be in.(select one) *M hou die tandeborsel in haar regterhand terwyl sy haar tande borsel. Benoem die posisie waarin haar skouer sal wees. (kies een)* @+abduction and internal rotation *abduksie en interne rotasie*	*M borsel haar tande. In watter posisie sal haar voorarm wees (kies een)* @supination *supinasie* @+pronation *pronasie* @mid position *midposisie* ?A man is using a hammer to hit the nail into a peace of wood. What motion is taking place at his wrist when he lifts the hammer (select one) *'n Man gebruik 'n hammer om die spyker in die hout in te slaan. Watter beweging vind by sy pols gewrig plaas. (kies een)* @+radial deviation and extension *radiale deviasie en ekstensie* @radial deviation and flexion *radiale deviasie en fleksie* @ulnar deviation and flexion *ulnare deviasie en fleksie* @ulnar deviation and extension *ulnare deviasie en ekstensie* ?M is carrying a heavy book bag over her left shoulder. To prevent the bag from

-Content area	Knows	Comprehends
	@abduction and external rotation *abduksie en interne rotasie* @adduction and internal rotation *adduksie en interne rotasie* @adduction and external rotation *adduksie en eksterne rotasie* ?Depressing the button of the aerosol can to spray deodorant requires the agonist function of…(select one) *Om die knoppie van 'n reukweerder spuitkannetjie te druk vereis die agonis funksie van..(kies een)* @flexor digitorum superficialis and lumbricales *fleksor digitorum superfisialis en lumbrikales* @+flexor digitorum superficialis and flexor digitorum profundus *fleksor digitorum superfisialis en fleksor digitorum profundus* @flexor digitorum porfundus and lumbricals *fleksor digitorum profundus en lumbrikales* ? What motion takes place at the scapulae when the shoulders are pulled up(select one)	slipping off her shoulder she needs to control the movement with her scapula. What group of muscles should function as agonists to prevent the bag from slipping (select one) *M dra 'n swaar boeksak oor haar linker skouer. Om te voorkom dat die sak van haar skouer af glip moet sy die beweging van haar scapula beheer. Watter groep spiere sal as agoniste moet funksioneer om te verhoed dat die sak glip. (kies een)* @+elevators and retractors *elevators en retraktors* @depressors and retractors *depressie en retraksie* @elevators and protractors elevators en protraktors @depressors and protractors *depressie en protraksie* ?Using a roller to paint a small surface requires stable wrist function. What muscles will provide this stability (select one) *Om 'n klein area te verf met 'n roller vereis 'n stabiele polsgewrig. Watter spiere sal hierdie stabiliteit verleen. (kies een)*

-Content area	Knows	Comprehends
	Watter beweging vind by die scapulas plaas wanneer die skouers opgetrek word (kies een) @depression *depressie* @+elevation *elevasie* @retraction *retraksie* @protraction *protraksie*	 @wrist flexors *pols fleksore* @wrist extensors *pols ekstensore* @+wrist flexors and extensors *pols fleksore en ekstensore*
Lower limb	?During the swing through phase of walking the hip motion that allows the foot to clear the ground is called (select one) *Wat word die heup aksie wat die voet toelaat om van die vloer af op te lig tydens die deurswaai fase van loopgang genome (kies een)* @rotation *rotasie* @+hitching *kanteling* @abduction *abduksie*	?When climbing stairs the agonist muscle in the lower leg will be (select one) *Wanneer trappe geklim word sal die agonis spiere in die onderbeen die (kies een)* @+the ankle extensors *enkel ekstensore* @the ankle flexors *enkel fleksore* ?The downward action of a leg when cycling on a bicycle requires the agonist action of the hip muscles to be (select one)

-Content area	Knows	Comprehends
	@adduction *adduksie* ?At which joint of the foot does inversion of the foot take place (select one) *By watter gewrig van die voet vind inversie plaas (kies een)* @ankle joint *enkelgewrig* @intertarsal joints *intertarsalegewrigte* @+tarsal metatarsal joints *tarsaal-metatarsalegewrigte* ?The metatarsal phalangeal joints of the foot are (select one) *Die metatarsalfalangeale gewrigte van die voet is (kies een)* @hinge joints *skarniergewrig* @multiaxial joints multiaksiale gewrig @+biaxial joints *…bi-aksiale gewrig*	*Die afwaartse aksie van die been wanneer 'n fiets getrap word vereis die agonis aksie van die heup spiere om te wees (kies een)* @hip flexors *heupfleksore* @+hip extensors *heupekstensore* @hip abductors *heupabduktore* @hip adductors *heupadduktore* ?When getting up from a chair the antagonist function for the hip function will be the (select one) *Om op te staan uit 'n stoel uit moet die antagonis funksie van die heup funksie wees by die (kies een)* @+hip flexors *heupfleksore* @hip extensors *heupekstensore* @hip abductors *heupabduktore* @hip adductors

-Content area	Knows	Comprehends
		heupadduktore

ANNEXURE M: INFORMED CONSENT FOR ANONYMOUS QUESTIONNAIRES

BACKGROUND INFORMATION:

I am studying to obtain my masters degree in occupational therapy at the department of occupational therapy at the University of Pretoria. You are invited to volunteer to participate in our research project

THE TITLE OF THE STUDY:

THE EVALUATION OF AN INTERACTIVE MULTIMEDIA LEARNING RESOURCE BASED ON THE LEARNING STYLES OF FIRST YEAR OCCUPATIONAL THERAPY STUDENTS

This leaflet gives you information to help you to decide if you are willing to take part in this research. Before you agree you should fully understand what is involved. If you do not understand the information or have any other questions, do not hesitate to ask us. You should not agree to take part unless you are completely happy about what we expect of you.

The purpose of the study is to determine if an interactive learning resource (multimedia) that was developed for biomechanics which is part of aku 100 in the second half of the year will be compatible to all the learning-styles of first year occupational therapy students.

The research ethics committee of the University of Pretoria and faculty of health sciences granted written approval for this study.

EXPLANATION OF PROCEDURES TO BE FOLLOWED:

Today: you will draw a four digit number that you must keep so that you may use it every time you log on to the computer for this study. The name list and signed forms with your numbers will be kept in the safe at the occupational therapy department. The secretary and head of the department will be the only persons with access to this information. If at any time you forgot your number you may ask the secretary to look it up again.

After reading this information and signing the class list and consent form a data collection session will follow. This session will consist of the completion of a questionnaire to determine your learning style.

Second semester: there will be four sessions where short tests will be done together with the use of the multimedia. The sessions will be incorporated into the biomechanics lectures and will not require any additional time commitments from you. All students will take part in the session, even those that do not take part in the research. If you do not want your information to be used as part of the research you will log onto the computer with your student number in place of the four digit number.

The scores of these tests will not be used for your year mark. It will only be used for the purposes of the research. Your participation in the study will not have any effect on your test or exam marks for the course

If for any reason you prefer not to participate in the research now or at any time later you will still have to do the tests and study the multimedia. You will log on to the computer with your student number not the four digit number. The information gathered will then not be available to the researcher. This will ensure that the researcher will not be aware of which students are participating in the study or not.

Your participation in this study is voluntary. You can refuse to participate or stop at any time without giving any reason. As you will only use your four digit

number to log on to the computer the identity of the participants remains anonymous. Once the questionnaire was submitted it is no longer possible to recall it. We will not be able to trace your information. Therefore, you will also not be identified as a participant in any publication that comes from this study.

Please sign the class register to acknowledge receipt of this information leaflet. Your signature is not accent to participate in the study and will not be regarded as such.

Please log on to the computer with your four digit number now if you are willing to take part in the study. Complete and sign the attached consent form if you want to take part in the research.

Log on to the computer with your four digit number (or student number if not taking part) and the password supplied by the laboratory staff.

Complete the questionnaire to determine your learning style and submit. This may take about 20 minutes.

We will be available to help you with the questionnaire if you have any trouble in completing it.

We sincerely appreciate your help.

YOURS TRULY,

ELSJE RUDMAN

STUDENTS / PARTICIPANT'S INFORMATION LEAFLET & INFORMED

CONSENT FOR ANONYMOUS QUESTIONNAIRES

Researcher's name: Elsje Rudman

Student number: 21151556

Department of Occupational Therapy

University of Pretoria

Protocol number: S163/2009

Dear Participant / Student /

Please make sure you read the information leaflet before signing this form. Please sign this form if you would like to take part in the study as explained in the information leaflet. You will receive all the information and take part in all the aspects of the study even if you decide not to take part. This form will be kept in a safe place by the Department of Occupational Therapy and will not be available to the researcher to ensure your anonymity.

Detach the form from the information leaflet and hand it in to the supervisor (not the researcher) before you leave the class.

I hereby consent to take part in the research as explained in the information leaflet.

Name: _____

Student number: _____

Four digit number: _____.