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APPENDICES

Appendix A - NQF levels

The NQF consist of three bands, namely General Education (level 1 – schooling up to grade 9 and ABET), Further Education and Training (levels 2 – 4: grade 10 – 12), and Higher Education (levels 5 – 8). After completion of level 1 of the NQF, a learner could achieve a GETC and after completion of level 4 of the NQF, an FETC.

<table>
<tr><th>NQF LEVEL</th><th>BAND</th><th colspan="2">QUALIFICATION TYPE</th></tr>
<tr><td>8</td><td rowspan="4">HIGHER EDUCATION AND TRAINING</td><td colspan="2">• Post-doctoral research degrees
• Doctorates
• Masters degrees</td></tr>
<tr><td>7</td><td colspan="2">• Professional Qualifications
• Honours degrees</td></tr>
<tr><td>6</td><td colspan="2">• National first degrees
• Higher diplomas</td></tr>
<tr><td>5</td><td colspan="2">• National diplomas
• National certificates</td></tr>
<tr><td colspan="4">FURTHER EDUCATION AND TRAINING CERTIFICATE</td></tr>
<tr><td>4</td><td rowspan="3">FURTHER EDUCATION AND TRAINING</td><td colspan="2" rowspan="3">• National certificates</td></tr>
<tr><td>3</td></tr>
<tr><td>2</td></tr>
<tr><td colspan="4">GENERAL EDUCATION AND TRAINING CERTIFICATED</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">GENERAL EDUCATION AND TRAINING</td><td>Grade 9</td><td>ABET Level 4</td></tr>
<tr><td colspan="2">• National certificates</td></tr>
</table>

Source: http://www.saqa.org.za/show.asp?include=focus/ld.htm

Appendix B - PGCE course documents

Appendix C - Education paradigms

Appendix D - Baseline mathematics assessment

Appendix E - Letter of consent to participants

Appendix F - Data analyses tables

Table F-1 Summary of data analysis for the subject matter category in mathematics profile

Section 2.3.1	*Subject matter knowledge*
Baseline assessment	Careless or no errors, a few errors or solutions omitted, many errors, fundamental errors
Errors in LTD's	Errors made in calculations in learning task designs
Errors in observed lessons	Errors participant made in lessons observed or recorded

Table F-2 Summary of data analysis for pedagogical content knowledge category in mathematics profile

Section 2.3.2	*Pedagogical content knowledge*
Mason's levels	See Table 2.1
Pedagogy	Participant's handling of learner errors/misconceptions Quality of planning
Assessment	Traditional or more alternative and authentic and various forms
Context	Participants understanding of context of learners as viewed in LTD's and observed lessons
Curriculum	Knowledge of the curriculum according to LTD's and observed lessons
Classroom management	Issues such as discipline, handling classroom discussion, use of media, classroom culture

Table F-3 Summary of data analysis for the conceptions of mathematics category in mathematics profile

Section 2.3.4	***Conceptions of mathematics***
Orientation ***Thompson (1984)***	Content orientation or process orientation
Orientation ***Thompson et al. (1994)***	Computational, calculational or conceptually orientated
Ernest (1991) categories	Absolutist, instrumentalist, Platonist or problem-solving

Table F-4 Summary of data analysis for the beliefs category in mathematics profile

Section 2.3.4	***Beliefs regarding the teaching and learning of mathematics***
Role of teacher ***(Ernest, 1988)***	Transmitter, instructor, explainer, facilitator
Role of learner ***(Ernest, 1988)***	How the participant arranged learning experiences for the learners on a passive reception to active construction continuum

Table F-5 Summary of data analysis to determine the position of traditional/reform continuum of instructional behaviour profile

Section 2.3.5	***Traditional versus reform practices***

Values	Traditional – values content, correctness of learners' responses and mathematical validity of methods Reform – values finding patterns, making connections, communicating mathematically and problem-solving
Teaching methods	Traditional – expository, transmission, lots of drill and practice, step by step mastery of algorithms Reform – hands-on guided discovery methods, exploration, modelling. High level reasoning processes are central
Grouping learners	Traditional dominantly homogenous Reform dominantly heterogeneous

Table F-6 Summary of data analysis to determine the position of authoritarian/democratic continuum of instructional behaviour profile

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Official methods taught versus learners' methods encouraged. Intentionally differentiating between horizontal (informal learner methods) and vertical (more formal algorithms) mathematisation
Learner relations	Encourages individual competition or collaborative group work

Section 2.3.5	*Authority versus democracy*
Teaching style	Expository class teaching or also use of projects, group and invidualised work
Listening	Evaluative, interpretive or heuristic

Marge

Table F-7 Summary of subject matter knowledge analysis for Marge

Section 2.3.1	*Subject matter knowledge*
Baseline assessment	No errors, found additional solutions
Errors in LTD's	None encountered
Errors in lessons	None observed

Table F-8 Summary of pedagogical content knowledge analysis for Marge

Section 2.3.2	*Pedagogical content knowledge*
Mason's levels	Progressed from initially Level 1 to Level 5
Pedagogy	Towards the end began to take notice of and explore thinking behind learners' errors Well thought out and planned LTD's
Assessment	First SBE mainly traditional began to use journal entries and other alternative forms in second SBE

Section 2.3.2	***Pedagogical content knowledge***
Context	Showed some understanding of their context
Curriculum	Excellent
Classroom management	Good

Table F-9 Summary of conceptions of mathematics analysis for Marge

Section 2.3.3	***Conceptions of mathematics***
Orientation Thompson (1984)	Initially content, progressed towards process
Orientation Thompson et al. (1994)	Initially calculational, progressed towards conceptual
Categories Ernest (1991)	From instrumentalist to problem-solving

Table F-10 Summary of beliefs about teaching and learning mathematics analysis for Marge

Section 2.3.4	***Beliefs regarding the teaching and learning of mathematics***
Role of teacher (Ernest, 1988)	From instructor to explainer

Role of learner	Progressed from passive reception towards more active
(Ernest, 1988)	construction of learning in LTD's

Table F-11 Summary of traditional/reform instructional behaviour analysis for Marge

Section 2.3.5	***Traditional versus reform practices***
Values	Initially valued content and mastery thereof Later started foregrounding more high level reasoning
Teaching methods	From transmission and expository teaching to more problem-solving approach that used hands-on discovery, identification of patterns and modelling
Group work	Did make use of group work Usually pre-determined groups

Table F-12 Summary of authoritarian/democratic instructional behaviour for Marge

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Initially these were shown and taught. Later encouraged horizontal mathematisation first before proceeding to vertical mathematisation
Learner relations	Mostly positive with some difficulties noted in reflections
Teaching style	Initially expository class teaching but started to move towards a good balance of individualised and group work through tasks and projects
Listening	Initially evaluative moving towards more interpretive during second SBE

Lena

Table F-13 Summary of subject matter knowledge analysis for Lena

Section 2.3.1	*Subject matter knowledge*
Baseline assessment	No errors, omitted some solutions
Errors in LTD's	None encountered
Errors in observed lessons	None observed

Table F-14 Summary of pedagogical content knowledge analysis for Lena

Section 2.3.2	*Pedagogical content knowledge*
Mason's levels	Progressed from initially Level 1 to Level 4
Pedagogy	Later responded to questions with low level questions Did not investigate learners' errors Well thought out and planned LTD's
Assessment	First SBE mainly traditional. Used brain teasers as a warm-up at the start of lesson but not much use of alternative assessment even later in the year.
Context	Showed some understanding of their context
Curriculum	Excellent
Classroom management	Good

Table F-15 Summary of conceptions of mathematics analysis for Lena

Section 2.3.3	*Conceptions of mathematics*
Orientation Thompson (1984)	Initially content, progressed slightly towards more process orientated approach
Orientation Thompson et al. (1994)	Initially computational but progressed towards calculational

Categories Ernest (1991)	Remained instrumentalist

Table F-16 Summary of beliefs about teaching and learning mathematics analysis for Lena

Section 2.3.4	***Beliefs regarding the teaching and learning of mathematics***
Role of teacher (Ernest, 1988)	From transmitter to instructor
Role of learner (Ernest, 1988)	Initially very passive reception by learners. Later became more learner-centred in problem-solving approach and so slightly towards active construction

Instructional behaviour

Table F-17 Summary of traditional/reform instructional behaviour for Lena

Section 2.3.5	***Traditional versus reform practices***
Values	Mastering content and correctness of solutions still apparent throughout the year with only a slight attempt at improving conceptual understanding
Teaching methods	From transmission and expository teaching to more problem-solving approach. Supported identification of patterns but high level reasoning discussion not attempted
Group work	

Table F-18 Summary of authoritarian/democratic instructional behaviour for Lena

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Initially methods were shown and taught. Later made some attempt to elicit horizontal mathematisation first before proceeding to vertical mathematisation
Learner relations	Mostly positive

Teaching style	Initially expository class teaching but started to move towards a good balance of individualised and group work through tasks and projects
Listening	Remained evaluative throughout the year

Peta

Table F-19 Summary of subject matter knowledge analysis for Peta

Section 2.3.1	***Subject matter knowledge***
Baseline assessment	Fundamental errors
Errors in LTD's	None encountered
Errors in observed lessons	Some observed

Table F-20 Summary of pedagogical content knowledge analysis for Peta

Section 2.3.2	***Pedagogical content knowledge***
Mason's levels	Progressed from initially Level 1 to Level 3
Pedagogy	Later responded to questions with low level questions Did not investigate learners' errors Need a lot of support from lecturers in designing LTD's
Assessment	First SBE mainly traditional. Made some use of rubrics during second SBE
Context	Showed some understanding of their context. Worked more effectively with lower grades
Curriculum	Sufficient
Classroom management	Improved over the year but still demonstrated difficulties regarding classroom discipline

Table F-21 Summary of conceptions of mathematics analysis for Peta

Section 2.3.3	***Conceptions of mathematics***
Orientation	Remained content orientated throughout the year

Thompson (1984)	
Orientation	Remained computational
Thompson et al. (1994)	
Categories	Initially absolutist moving to instrumentalist later in the
Ernest (1991)	year

Table F-22 Summary of beliefs about teaching and learning mathematics analysis for Peta

Section 2.3.4	***Beliefs regarding the teaching and learning of mathematics***
Role of teacher	From transmitter to instructor
(Ernest, 1988)	
Role of learner	Initially very passive reception by learners. Later became
(Ernest, 1988)	more learner-centred in problem-solving approach and so slightly towards active construction

Instructional behaviour

Table F-23 Summary of traditional/reform instructional behaviour analysis for Peta

Section 2.3.5	***Traditional versus reform practices***
Values	Mastering content and correctness of solutions still apparent throughout the year
Teaching methods	From transmission and expository teaching to more surface problem-solving approach. Mathematical discussions not used and questions posed did not elicit high level reasoning
Group work	

Table F-24 Summary of authoritarian/democratic instructional behaviour for Peta

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Initially methods were shown and taught. Later an attempt

	to elicit horizontal mathematisation first before proceeding to vertical mathematisation
Learner relations	Extremely varied over the year. Struggled with discipline
Teaching style	Initially transmission with a move toward more hands-on discovery during second SBE.
Listening	Remained evaluative throughout the year

Kapinda

Table F-25 Summary of subject matter knowledge analysis for Kapinda

Section 2.3.1	***Subject matter knowledge***
Baseline assessment	Few careless errors, omitted some solutions
Errors in LTD's	None encountered
Errors in observed lessons	None observed

Table F-26 Summary of pedagogical content knowledge analysis for Kapinda

Section 2.3.2	***Pedagogical content knowledge***
Mason's levels	Progressed from initially Level 1 to Level 3
Pedagogy	Later responded to questions with low level questions Did not investigate learners' errors Very creative LTD's but not demanding high level of mathematical reasoning from learners
Assessment	Embraced alternative assessment as the year progressed, using journal entries, self-assessment, rubrics, peer-assessment and presentations
Context	Showed an excellent understanding of learners' contexts
Curriculum	Good
Classroom management	Good

Table F-27 Summary of conceptions of mathematics analysis for Kapinda

Section 2.3.3	*Conceptions of mathematics*
Orientation Thompson (1984)	Initially content, progressed slightly towards more process orientated approach
Orientation Thompson et al. (1994)	Initially computational but progressed towards calculational
Categories Ernest (1991)	Remained instrumentalist

Table F-28 Summary of beliefs about teaching and learning mathematics analysis for Kapinda

Section 2.3.4	*Beliefs regarding the teaching and learning of mathematics*
Role of teacher (Ernest, 1988)	From instructor to explainer
Role of learner (Ernest, 1988)	Attempted to include learners right from the beginning in a surface problem-solving approach which required active construction from learners but not at a very high level

Instructional behaviour

Table F-29 Summary of traditional/reform instructional behaviour analysis for Kapinda

Section 2.3.5	*Traditional versus reform practices*
Values	Mastering content and correctness of solutions still apparent throughout the year with only a slight attempt at improving conceptual understanding
Teaching methods	From expository teaching to more problem-solving approach. Supported identification of patterns but high level reasoning discussion not attempted
Group work	

Table F-30 Summary of authoritarian/democratic instructional behaviour for Kapinda

Section 2.3.5	*Authority versus democracy*
Algorithms/techniques	Encouraged learners to use horizontal mathematisation first before proceeding to vertical mathematisation
Learner relations	Very positive
Teaching style	Initially expository class teaching but started to move towards a good balance of individualised and group work through tasks and projects
Listening	Remained evaluative throughout the year

Anabella

Table F-31 Summary of subject matter knowledge analysis for Anabella

Section 2.3.1	*Subject matter knowledge*
Baseline assessment	Fundamental errors
Errors in LTD's	Some encountered
Errors in observed lessons	Some observed

Table F-32 Summary of pedagogical content knowledge analysis for Anabella

Section 2.3.2	*Pedagogical content knowledge*
Mason's levels	Progressed from initially Level 1 to Level 2
Pedagogy	Later responded to questions with low level questions Did not investigate learners' errors Quality of LTD's improved with lower grades during second SBE
Assessment	First SBE mainly traditional. Made some use of rubrics during second SBE
Context	Showed some understanding of their context. Worked more effectively with lower grades
Curriculum	Sufficient
Classroom management	Overall good but did not always optimise interactions with

	individuals or groups while learners worked on tasks

Table F-33 Summary of conceptions of mathematics analysis for Anabella

Section 2.3.3	*Conceptions of mathematics*
Orientation Thompson (1984)	Remained content orientated
Orientation Thompson et al. (1994)	Initially computational moving towards more calculational with the lower grades during second SBE
Categories Ernest (1991)	Remained instrumentalist throughout the year

Table F-34 Summary of beliefs about teaching and learning mathematics analysis for Anabella

Section 2.3.4	*Beliefs regarding the teaching and learning of mathematics*
Role of teacher (Ernest, 1988)	Initially demonstrated role of transmitter but later in the year became more of an instructor
Role of learner (Ernest, 1988)	Initially very passive reception by learners. Later became more learner-centred in surface problem-solving approach and so slightly towards active construction although high level reasoning not encouraged

Instructional behaviour

Table F-35 Summary of traditional/reform instructional behaviour analysis for Anabella

Section 2.3.5	*Traditional versus reform practices*
Values	Mastering content and correctness of solutions still apparent throughout the year
Teaching methods	From transmission and expository teaching to more surface problem-solving approach. Mathematical discussions not used and questions posed did not elicit

	high level reasoning
Group work	

Table F-36 Summary of authoritarian/democratic instructional behaviour for Anabella

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Initially methods were shown and taught. Later an attempt to elicit horizontal mathematisation first before proceeding to vertical mathematisation
Learner relations	Mostly fine. Engaged better with learners in lower grades. Initially had some discipline difficulties
Teaching style	Initially transmission with a move toward more hands-on discovery during second SBE.
Listening	Remained evaluative throughout the year, demonstrating some evidence of interpretive listening when working with individuals

Sophie

Table F-37 Summary of subject matter knowledge analysis for Sophie

Section 2.3.1	***Subject matter knowledge***
Baseline assessment	Fundamental errors
Errors in LTD's	Some encountered
Errors in observed lessons	Many observed

Table F-38 Summary of pedagogical content knowledge analysis for Sophie

Section 2.3.2	***Pedagogical content knowledge***
Mason's levels	Progressed from initially Level 1 to Level 2
Pedagogy	On occasion responded to questions with low level questions Did not investigate learners' errors

	Initially planning was incomplete and of a low quality. Later in the year, the LTD's improved and the planning became more complete.
Assessment	Remained mainly traditional throughout the year
Context	Struggled to understand the context of learners although some attempt was made to make use of authentic contexts during second SBE
Curriculum	Appeared to show gaps
Classroom management	In most lessons observed, and by her own admission, she struggled a lot initially with discipline having some improvement towards the end of the year making use of a reward chart. Time management and management in terms of learners' relations and classroom culture problematic throughout year

Table F-39 Summary of conceptions of mathematics analysis for Sophie

Section 2.3.3	***Conceptions of mathematics***
Orientation Thompson (1984)	Remained content orientated throughout the year
Orientation Thompson et al. (1994)	Remained computational
Categories Ernest (1991)	Initially absolutist and later instrumentalist

Table F-40 Summary of beliefs about teaching and learning mathematics analysis for Sophie

Section 2.3.4	***Beliefs regarding the teaching and learning of mathematics***
Role of teacher (Ernest, 1988)	Initially transmitter moving to instructor towards the end of the year
Role of learner	Initially very passive reception by learners. Later became

(Ernest, 1988)	more learner-centred in surface problem-solving approach but context appeared to dominate rather than mathematical reasoning or thinking

Instructional behaviour

Table F-41 Summary of traditional/reform instructional behaviour analysis for Sophie

Section 2.3.5	***Traditional versus reform practices***
Values	Mastering content and correctness of solutions still apparent throughout the year
Teaching methods	From transmission and expository teaching to more surface problem-solving approach. Mathematical discussions not used and questions posed did not elicit high level reasoning
Group work	

Table F-42 Summary of authoritarian/democratic instructional behaviour for Sophie

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Initially methods were shown and taught. During the year some attempt was made to encourage learners to be more independent in their thinking
Learner relations	Extremely varied over the year. Struggled with discipline
Teaching style	Initially transmission with a move toward more hands-on discovery during second SBE, but mathematical outcomes disappearing into dominant, not optimal contexts
Listening	Remained evaluative throughout the year

Toni

Table F-43 Summary of subject matter knowledge analysis for Toni

Section 2.3.1	***Subject matter knowledge***

Baseline assessment	No errors
Errors in LTD's	None encountered
Errors in observed lessons	One observed

Table F-44 Summary of pedagogical content knowledge analysis for Toni

Section 2.3.2	***Pedagogical content knowledge***
Mason's levels	Progressed from initially Level 1 to Level 5
Pedagogy	Towards the end began to take notice of and explore thinking behind learners' errors Well thought out and planned LTD's
Assessment	First SBE mainly traditional began to use journal entries, self assessment and rubrics during second SBE
Context	Showed some understanding of their context but struggled to design tasks with authentic context for learners
Curriculum	Excellent
Classroom management	Good, especially discipline and interaction with learners

Table F-45 Summary of conceptions of mathematics analysis for Toni

Section 2.3.3	***Conceptions of mathematics***
Orientation Thompson (1984)	Initially content orientated, progressed towards process orientated later in the year
Orientation Thompson et al. (1994)	Initially calculational, progressed towards conceptual
Categories Ernest (1991)	Initially instrumentalist moving to Platonist during year

Table F-46 Summary of beliefs about teaching and learning mathematics analysis for Toni

Section 2.3.4	***Beliefs regarding the teaching and learning of mathematics***

Role of teacher (Ernest, 1988)	Progressed from instructor to explainer
Role of learner (Ernest, 1988)	Progressed from passive reception towards more active construction of learning in LTD's

Instructional behaviour

Table F-47 Summary of traditional/reform instructional behaviour analysis for Toni

Section 2.3.5	***Traditional versus reform practices***
Values	Initially valued content and mastery thereof Later started foregrounding more high level reasoning
Teaching methods	From transmission and expository teaching to more problem-solving approach that used hands-on discovery, identification of patterns and exploration
Group work	Did make use of group work Usually pre-determined groups

Table F-48 Summary of authoritarian/democratic instructional behaviour for Toni

Section 2.3.5	***Authority versus democracy***
Algorithms/techniques	Initially these were shown and taught. Later encouraged horizontal mathematisation first before proceeding to vertical mathematisation
Learner relations	Mostly positive, especially interaction while learners completing tasks
Teaching style	Initially expository class teaching but started to move towards a good balance of individualised and group work through tasks and projects
Listening	Initially evaluative moving towards being interpretive during second SBE

Appendix G - Examples from portfolio

Example of initial aim of education

VIEWS OF EDUCATION & FACILITATING LEARNING BEFORE THE PGCE JOURNEY STARTED

I expected PGCE to be a *walk in the Park* and a relaxed course compared to BSc. Mathematics. I did not expect a *walk in a Canyon*.

PURPOSE FOR ENROLLING IN PGCE PROGRAMME

- I enrolled for BSecEd(Sci) in 2004. The PGCE is part of the BSecEd(Sci) therefore I had to complete the PGCE to graduate. Although I thought PGCE is a good course to open doors for future career opportunities, I did not plan to become a teacher after completing the PGCE.
- My career goal was to go into Ministry after completing the PGCE.

AIM OF EDUCATION:

In January 2008 believed that "Education lays a foundation of general knowledge, basic manners, academic literacy and qualities. Learners absorb information. Education is the transfer of knowledge and wisdom.

Education is important to enrich people, and the community. It promotes development of civilization. Therefore the aim of education is to lay building blocks to build a stable strong "house." "

INITIAL VIEWS OF EDUCATION:

1. the teacher gives information to the learners
2. transcendental learning tasks is a good idea in theory but will not work in practice.
3. teaching is an unchallenging, stagnating job, with continuously the same routine.
4. learners only learn to forget
5. group work is the same as cooperative learning, and is ineffective since learners copy work from each other and do not focus when working together.

Example of a Learning task design

Learning Task Design

Type of paradigm			1. Transmission	
			2. Transaction	
			3. Transformation	X
			4. Transcendental	
Learning subject/area:			Mathematics: Volumes and Surface Areas	
Grade:			Gr. 10	
Date:			02/04/2008	
Time allocate to Learning Task (LT):			1 period- 30 minutes	
Critical and Developmental Outcomes	**Critical Outcomes**		**Developmental Outcomes**	
	1. Problem Solving	X	1. Learn more effectively	X
	2. Teamwork	X	2. Responsible citizenship	
	3. Self management	X	3. Culturally & aesthetically sensitive	
	4. Research & critical analysis		4. Explore education & career opportunities	
	5. Effective communication	X	5. Entrepreneurship	
	6. Science & technology			
	7. The world as a set of related systems	x		

Content: Learning Outcomes (LO'S) & Assessment Standards (AS's)		
LO1: Number & Number relationships	10.1.1 Identify rational numbers	
	10.1.2 Simplify using exponent law, round rational/irrational numbers	
	10.1.3 Investigate number patterns	
	10.1.4 Use simple and compound growth formula	
	10.1.5 Understand fluctuating foreign exchange rates	
	10.1.6 Solve non-routine, unseen problems	
LO2: Functions & Algebra	10.2.1 Work with various types of functions	
	10.2.2 Generate graphs to generalize effect of parameters	
	10.2.3 Identify characteristics of functions and sketch graphs	
	10.2.4 Manipulate algebraic expressions	
	10.2.5 Solving equations and inequalities	
	10.2.6 Use models for real life problems	
	10.2.7 Investigate average rate of change in function	

LO3: Space, Shape & Measurement	10.3.1 Effect on volume/surface of cylinders/prism by multiplying dimension	X
	10.3.2 Investigation of triangles, quadrilaterals and other polygons	
	10.3.3 Represent geometric figures in Cartesian plane	
	10.3.4 Transformations	
	10.3.5 Similarity of triangles and use of trigonometric functions	
	10.3.6 Solve two dimensional problems with trigonometric functions	
	10.3.7 Contribution of geometry and trigonometry by different cultures	
LO4: Data Handling & Probability	10.4.1 Collect, organise and interpret univariate numerical data	
	10.4.2 Use probability models and Venn diagrams	
	10.4.3 Identify sources of bias and errors. Make conclusions/predictions	
	10.4.5 Use theory in authentic form of assessment	

Learning Task outcomes:	1. Learners should determine which volume of two cylinders is the biggest. 2. Learners should understand the effect of change in height vs. change in radius in a cylinder 3. learners should be able to calculate volume and surface area of a cylinder 4. learners should be able to use above knowledge to solve real life problems
Learning task assessment standards:	1. observation during experiments 2. marking of homework assignment
Integration with other subjects:	

Real life problem that Learners need to solve:

Learners should investigate changes in volume due to radius change versus height change of jam and fruit tins in a fabric, and advise the manager about the cost difference between them.

Product Outcome:

Learners should be able to calculate the volumes and surface areas of cylinders, and understand the relation between the above mentioned.

Authentic Learning context:	
Organisation of Learning Space:	Tables are moved head-to-head, learners sit in their cooperative learning groups.
Roles, functions and organisation of participants:	Learners participate in discussions, and also during the experiment. Learners cooperatively work together. FOL presents the learning task, and then reduces involvement during experiment. Thereafter FOL explains concepts, and formula.
Material and Equipment:	Two A4 sheets of paper 350g Whole-wheat puffs

	Ruler Textbooks
Learning Process:	Learners first work in cooperative learning groups, and learn through experience. Thereafter transmission, transaction and transformation take place when facilitator of learning explains definitions and formula. Learners engage in meta-learning at home when completing a homework assignment.
Learning Product:	- two cylinders which have been filled with puffs - Worksheet - Homework assignment
Resources:	- Shuters Mathematics Grade 10 Textbook

Learning content:

Introduction:

Today we are discussing the concepts of surface area and volume, and their relationship to each other. During today's lesson we will investigate the Cylinder.

Knowing to calculate surface areas and volumes is important in many occupations and in everyday life. Engineers, builders, plumbers, painters and many other people often work with areas and volumes.

Class activity:

Learners work in cooperative learning groups of 4 learners per group. Learners may perform and discuss the experiment together as a group.

The worksheet needs to be handed in at the end of the period.

Experiment (part 1):

Each group get two A4 sheets of paper. Take the first sheet of paper, roll it up to form a baseless cylinder. Now take the second paper, rotate it, and form another baseless cylinder.

Use the wheat puffs and think about the volume of each cylinder and answer the following question.

Question 1:
- Are the two volumes equal?
- Does the short cylinder have greater volume?
- Does the tall cylinder have greater volume?

Discussion:

Revise definitions of:
- Surface Area
- Volume

Revise formula of:
- Circle
- Rectangle
- Surface area of open/closed cylinder
- Volume of cylinder

Discuss why volumes of two cylinders from experiment differ.

Experiment (part 2):
Question 2:

Use your rulers and measure the surface area and volume of the two cylinders.

Homework:

A homework assignment is handed out, to be completed the next period.

HOMEWORK ASSIGNMENT

1. A factory makes jam tins. The radius of the lid of a tin is 50mm and it is 140mm deep.

   a. calculate the volume of the tin.

   b. A bigger tin is made for fruit. It is twice as deep as the jam tin and its lid has the same radius as the jam tin. Calculate its volume and compare it with your answer in (a).

2. If we double the radius and the height of a tin, will the volume also double? Explain your answer.

3. Suppose you have been appointed to advise the management of the jam tin factory about the cost of making their tins. The cost depends on the amount of metal used. Calculate the surface area of each of the two tins, and report how this will affect the cost.

   a. What happens to the surface area when you double the height but not the radius?
   b. What happens to the surface area when you double the radius but not the height?
   c. What happens to the surface area when you double both the height and radius?

Reflection: My own LT operationized in Cluster

Honestly, it did not go as well as I expected. Usually I am not afraid of speaking in front of an audience. I think what made this different was the fact that I knew I was being critically assessed, and every sentence or movement was watched.

My topic was Volumes and Surface areas of cylinders, Gr.10 Maths. The class enjoyed the practical work, where the cooperative learning groups had to figure out which cylinder has the biggest volume.

I think my topic and ideas were very good, I just did not present the task as well as I could.

Possible reasons why it did not go as well as I hoped:

- I decided to change my topic two days before the presentation. I figured that this topic would be more practical than my first idea for a topic. That might be true, but I don't think it was a good idea to change topics on such late stage, because I didn't have enough time to prepare *well enough*.

- Some of the learners in the CLG cluster didn't have maths as a subject after Gr.9. Therefore I think it was challenging for me to operationize a a learning task where the learners are actively involved and participate in figuring out the problem. Especially if I wanted to move into the transcendental paradigm where I do not give learners the formula, etc. I think it was more challenging for me to present a good learning task, than for example a Gr.5 Life Orientation facilitator, since the audience are more familiar with Gr.5 work.

- The cluster student who presented just before me, needed a lot of space in the classroom and moved the tables to the back of the class. I forgot to move the tables forward before starting my lesson. Therefore the gap between me and the learners was too big and that affected interaction.

How can I improve?

1. next time choose a topic well in advance and stick with it. Then become a specialist in that field before I walk into the classroom so that I will feel more competent.
2. move tables closer to the front to improve interaction.

Learning Product

Experiment 1:

The wheat puffs completely filled the tall cylinder, but not the wider cylinder, although their surface areas are the same.
Cylinders with the same surface area don't have the same volume.

The area of the base of a cylinder = πr^2
The volume of a cylinder = $\pi r^2 h$

The volume will increase/decrease more rapidly with a radius change than with a height change.

Experiment 2:

Use formula of the volume of a cylinder $= \pi r^2 h$
$= 3.14(7.5)(29.7)$
$= 699.4 cm^3$

Example of a reflection

LEARNING TASK 2: VOLUMES

(presented in Cluster Groups).

REFLECTION:
This was my **worst learning task** which has been executed.

INITIATING LEARNING:

LEARNING TASK DESIGN (LTD)
- Real life challenge was neither urgent nor was it a realistic challenge since none of the learners work in a fabric where jam jars are made.
- did not plan media well (posters was written too small)
- I did not understand the terms ***assessment standards*** and ***learning content***
- no assessment rubrics or memorandum included
- the following was not included in the learning task design:
 1. learning task sequence number
 2. number of learning tasks presented in each paradigm
 3. integration with other learning areas
 4. supportive resources
 5. learning task categories
 6. learning product (homework assignment)

LEARNING TASK PRESENTATION (LTP)
- history of volumes is irrelevant to learners
- presentation was unclear and disorganised, there was no chronological flow during the learning task presentation.

LEARNING: AUTHENTIC LEARNING (AL)
Learning was not authentic since no real meta-learning took place. Learners immediately worked in cooperative learning groups. It was ineffective since learners could not individually contribute to the group.

MAINTAINING LEARNING:

LEARNING TASK EXECUTION (LTE)
Interaction between facilitator and learners was poor; tables were moved too far to the back. Facilitator also did not give enough chance for the learners to answer questions and to interact. All the learners did not participate since meta-learning did not take place, therefore not all learners attempted to contribute. Only the stronger mathematical learners did the work.

LEARNING TASK FEEDBACK (LTF)
Learning task feedback was not at all effective. I did give acknowledgement to learners by my presence and interest on how they solved the problem of discovering which cylinder has biggest volume. I did not give any resilience because I did not really encourage anyone who seemed to be disappointed for not finding a solution. I did ask clarifying questions to determine where the learners are, but did not use the information I gained to encourage

meta-learning actions. When I saw that learners were on the wrong track (for example not knowing what the radius means), I did not guide the learner in realising he was on the wrong track. I did not require resourcefulness since I did not suggest to any learner to find resources or advise auto-education. I provided edutainment only after the learning task was completed. This did not

LEARNING TASK CONSOLIDATION (LTC)
No consolidation took place at the end of the learning period; therefore I did not evaluate the *rate of progress* or *quality of learning*, and although I gave homework, I did not really provide an effective *continued challenge*.

Appendix H - Example of assessment report

PGCE report

Name of student: Toni

Date: 9 May 2008

Time: 12:20 – 13:30

Grade: 10 Mathematics

Topic: Word problems

General comments

- You appear confident, at ease and friendly, all of which are assets in the teaching profession.
- Your patience and passion will also stand you in good stead!
- Your interaction with the various groups is to be commended.
- Congratulations on knowing so many of the learners' names already. I think this is one of the most important ways of gaining respect and maintaining discipline.
- Watch out for overuse of "teacher pauses" – where you ask a question and leave a slight pause, but answer the question yourself anyway. Consider the classroom culture this encourages – learners simply wait for you to answer the question.

Pedagogical issues

- This was a nice idea for groupwork – good distribution.
- I know that you are limited by this textbook, but if you can, try not to get too "textbook bound". Try to find some real-life problems for learners to solve that will interest them and things they are currently involved with.
- In my opinion word problems allow learners to a) practice the principles of problem solving (see Polya for readings) and b) to practice identifying the unknown variable and representing the other information that is known in terms of the unknown variable. For achieving the second outcome, I would avoid encouraging learners to work with two unknowns (x and y) for example. I would rather encourage them to practice writing information in terms of only one variable. Also, using two different variables does not always allow one to solve a problem.
- I did not think that your lesson had turned to "chaos" – try to differentiate between bad noise and constructive noise. I doubt you will be able to avoid the latter in group work. Consider also the implications of having different cultures in your classroom and how this may contribute to what you evaluate to be "too much noise" or "chaos".
- When you decided to revert back to a more traditional teacher-centred approach, I thought you could have first asked which learners would liked to have written their solution on the board and explained their thinking to the rest of the class.

- When you were showing them the age solution, I thought it would have helped if you had used the concept of both sides of an equation needing to be equal and used actual values to demonstrate the "11x" greater principle and avoid the misconception you also fell into.
- In reflecting on your practice theory, consider the value of an explanation from you versus self-discovery on their part. Although self-discovery is not always possible, or practical, it can be practiced in the mathematics classroom far more than it is. It does not mean that the learners are left alone to discover everything, but that you guide them to an understanding through various questions and prompts – called scaffolding. Scaffolding would be a good term for you to read up on in the literature (theory) on mathematics education, and to try out in your own practice in order to feed into your practice-theory.
- I have attached an article for you to read through to acquaint yourself more with the theory of Realistic Mathematics Education (RME) and in particular with the concepts of horizontal and vertical mathematisation. I think that in this lesson, more use of horizontal mathematisation is helpful in helping learners understand. For example, learners could have been encouraged to use diagrams/pictures or tables to represent the information provided in the word problem and their understanding thereof. This will help them to ascertain what they know and what they are trying to find. For example: (Janet and Ellen problem)

	Now	**3 years ago**
Janet	X	x - 3
Ellen	$30 - x$	$30 - x - 3$

Equation: $x - 3 = 11(30 - x - 3)$

- The textbook shows learners the different "patterns" of word problems that one may encounter but I am concerned that this may lead to instrumental rather than relational understanding. I suggest you look up (either on google, or in a book in the library – also see attached chapter) some readings by Richard Skemp on relational and instrumental understanding to further your practice-theory in this regard. It will help you reflect on the type of instruction these learners are accustomed to and whether or not you agree with this or intend to structure your practice-theory differently to endorse a more constructivist approach to teaching.

Suggestions:

- Sending worksheets down the rows saves time rather than you having to hand them out individually.
- Write the information about the pages (p. 27 I think) from the textbook on the board. That way you would not have to keep repeating it.
- Being able to translate from English/Afrikaans into mathematical expressions is a skill that is vital to being able to solve word problems using equations. Consider preceding a lesson

like this either by a baseline assessment where you establish how proficient they are at translations or by first having them complete a worksheet on translations.

- Help take the pressure off yourself by having a Plan B already in your planning, in case learners are not able to commence or carry out the exercise as you intended. You could also consider planning some scaffolding exercises and/or questions to have available if they need a "kick-start".
- What about presenting a real-life problem to learners to get them challenged and excited. They could meta-learn by solving that one on their own, or through you scaffolding them through it, and then go on with others. Remember that you want to grab their attention right at the beginning of the lesson to set the learning culture.

Some reflections to consider (and please email me a written response within a week again):

- What was your outcome(s) for the lesson? Do you think this was achieved, and if so how can you provide us with evidence thereof?
- Propose a mark for this lesson.

Appendix B - PGCE course documents

UNIVERSITY OF PRETORIA
Faculty of Education

LECTURER
Information Package

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Compiled January 2006

THE PGCE PROGRAMME
Becoming an authentic facilitator of learning

INTRODUCTION

Globally more and more visionaries, futurists, corporate leaders and change agents are becoming increasingly concerned about the rapid decrease in the quality and relevance of our educational outcomes (Goodlad, 1983:66; Grulke, 2000:56; Senge, Cambron-Mccabe, Lucas, Smith, Dutton, and Kleiner, 2000:27-48; nuwe artikel). "More than half of America's young people leave school without the knowledge or foundation required to find and hold a good job" (Dreyden and Vos, 1999:29) and it could not be very different in other developed countries, not even trying to imagine the state in developing countries. Even many of those school leavers, world wide, who find jobs are so ill equipped that the corporate world need to retrain them to do the job they need to do at extremely high additional cost (Senge, Cambron-Mccabe, Lucas, Smith, Dutton, and Kleiner, 2000:8) and, in addition, employers complain about the lack of even the basic life skills of beginner employees (Claxton, 1999:274-275). And although the situation is rapidly deteriorating we insist on knowing what to do to rectify it by simply doing more of what we have done before. "[I]t's so much more comfortable to live in this nice illusion that we know much more than we actually do. The only problem with this is that it is an illusion" (Peck, 1993:75). Living in this illusion has caused civilization to hurtle through one of the most significant turning points in history. (Covey, 2004:2). We are entering an era of a rapidly increasing, uncertain emerging future for which society is totally unprepared (Drucker, 2000:8). It has brought about an "anxiety-ridden age of insecurity" (Hargreaves, 2003:28) that carries with it the danger of the demise of civilization, warns Tarnas (1991:191). Slattery (1995: 248) explicates in the following way: "Contemporary society, like education, has reached the apex of modernity, an absurd psychodrama of self-destruction" and most of society completely unaware of it. This time calls for an unprecedented change in the human condition (Covey, 2004:12) and to empower the incalculable assets of human intelligence and creativity (Land and Jarman, 1992:68) to survive this relentless challenge. "The seismic scope of this change forces us to completely rethink everything we've ever understood about learning, education, schooling, business, economics and government" (Dreyden and Vos, 1999:21). Most fortunately is that the human condition can change. In fact, we now only begin to understand the incredible potential human beings posses to do so. But unless education, therefore, expeditiously acquires an innovative new paradigm that would cultivate practical, creative wisdom to enhance this most profound revolution in the human condition, it cannot fulfil its aim.

WHAT IS THE AIM OF EDUCATION?

To determine the aim of education, it is important to know what the purpose of life is, because the aim of education obviously needs to fulfil the purpose of life!

- **WHAT IS THE PURPOSE OF LIFE?**

Unfortunately, our current world view is still governed by 17th Century Newtonian science consciousness which has caused progressive disenchantment, increasing non-participation, rigid distinction, and uncompromising fragmentation (Berman 1988: 16; Bohm, 1990:1-2), 'providing an increasingly unworkable and dangerous blueprint for human thought and activity' (Tarnas 1991: 409). This alienation has broken down fundamental relationships, and since it is relationships that provide meaning we have lost meaning in an ultimate and religious sense. When meaning is lost, value systems starts to crumble and with it life, the individuals and community that lives by them and we lose our sense of being (Berman, 1988:15), and subsequently the purpose of life. We have to agree with Levin (1998: 419) that it is only the restoration of vision that will expose the truth (Gr Aletheia = opening or unconcealment ≠ correctness or correspondence) of our potential as human beings contained in authentic wholeness (Berman, 1988:23) that will revive our purpose of life. In this context, the purpose of life is to become fully and passionately engaged in the great adventure of discovering who we really are, what we are actually capable of, and what our ultimate purpose is. To accomplish this, we need to continually seek and create opportunities to stretch ourselves way beyond what we may think our capacity is: continuously tuning our bodies, expanding our senses, cultivating our minds,

exploring our consciousness, deepening our relationships, and serving others – in short, the purpose of life is ***to fully utilise human potential*** (Leonard and Murphy, 1995:14). This is not only a useful purpose, it is absolutely necessary because "[a]ccording to some of the most distinguished and thoughtful students of the mind, one of the most devastating and damaging things that can happen to anyone is to fail to fulfil his potential. A kind of gnawing emptiness, longing, frustration, displaced anger takes over when this occurs. Whether the anger is turned inward on the self or outward towards others, dreadful destruction results, (Hall, 1976:4).

- **IS THIS PURPOSE OF LIFE EDUCATIONAL?**

Since the essence of being human consists of our capacity to care (Levin 1998: 22), our purpose of life always require an ethical practice of utilising our full potential through which a corresponding moral character with underpinning values is constructed (UNESCO 1998: 244-245; Noddings, 1992; Noddings, 1993; Noddings, 1995; Noddings, 2002; Palmer 1998; Palmer 1999; Miller 1999; Tatum 2002; Niebuhr 1996; Fullen 2001). Since caring is the essence of love and love "is the will to extend one's self for the purpose of nurturing one's own and another's spiritual well growth" (Peck, 1990:85), Having a life purpose and pursuing it is always accompanied by great responsibility towards everything and everyone including oneself. The purpose of life should therefore always be guided by a norm for it to be educational. The norm is to fully utilise human potential ***towards a safe, sustainable and prosperous universe for all***.

- **WHEN WILL THIS AIM BE ACHIEVED IN EDUCATION?**

Because everything changes so quickly, we do not know what the future will be like. We also know so very little about the vastness of our potential: "Opening to the area of self-knowledge requires going into a world of invisibles beyond the conscious mind – where our imagination, intuition and dream world gives us access to our inner wisdom. Here is where 90% of our potential lies. This is where we connect with our wave of possibilities" (Land and Jarman, 1992:156). "Our destiny is to learn and keep on learning for as long as we live" (Leonard and Murphy, (1995:xv). That is why learning in education is a process of ***lifelong learning***.

- **WHAT IS THE KIND OF LEARNING THAT EDUCATION REQUIRES?**

You could imagine that the kind of learning to fully utilise human potential towards a safe, sustainable and prosperous universe, has to be something very special. It is! Since education is learning to live life and since the future is increasingly unknown, our world "is beset with problems that cannot be solved with either the traditional world-view or by existing interpretations of the newly discovered laws of nature" (Land and Jarman, 1992:95) and Einstein emphasises that you cannot solve a problem with the same consciousness that created it. "And even for graduates, knowledge gained in a degree courses is often outdated even before graduation" (Dreyden and Vos, 1999:31) We therefore simply do not have the knowledge to "explain where we have been nor inform us what next to do" (Slattery, 1955:244). The kind of learning that is therefore required in education is what to do when you don't know what to do (Claxton, 1999:11) and getting increasingly competent at knowing when, where, why, how and what to do when you don't know what to do. We do this because it gives meaning to our lives and our search for meaning is our primary motivation for living (Frankl, 1984:121). This learning is the construction of meaning but since "[t]his meaning is unique and specific in that it must and can be fulfilled by him alone" (Frankl, 1984:121), it is the construction of meaning by the learner him/herself. And only when meaning is constructed by the learner him/herself, "does it have significance which will satisfy his own *will* to meaning which means that the learner is able to use the constructed meaning to do something creatively new. The kind of learning that education requires, therefore is ***the construction of meaning by the learner him/herself, who is then able to use it to do something creatively new.*** This is the most natural innate power of the human being. In fact, we are engaged in this kind of activity from the very beginning of our lives.

- **HOW WILL THIS KIND OF LEARNING BE ACHIEVED?**

When we look at the kind of learning that education requires, we discover something interesting. Only the learner can do it. No one can do it for or on behalf of the learner. Piaget (1977:15) says that "[e]ach time one prematurely teaches a child something he could have discovered himself, the child is kept from inventing it and consequently understanding it completely". Understanding does not come through explanation, but through experience. Such an experience can only be ***facilitated*** by others (Claxton, 1999:17; Holstock, 1987:73). And for this kind of learning experience to be achieved in the most effective way, it also *has* to be facilitated by an extremely well-educated and highly professional facilitator of learning (FOL).

- **WHAT IS THE AIM OF EDUCATION THEN?**

The aim of education is to educate learners to fully utilise their human potential towards a safe, sustainable and prosperous universe for all, through facilitating lifelong learning. . And this aim is not only a nice choice. In the words of Sam Isaacs, the SAQA Executive Officer, it is a requirement: "The international trends of lifelong learning and highest quality in education and training require South Africa to develop, nurture and advance widened participation in a quality learning system that allows all learners, throughout their lives, to develop their full potential" – and this is what facilitating learning is all about.

WHAT IS FACILITATING LEARNING?

Current education is characterised by an outside-in paradigm: Something must be transferred by a teacher from outside the learner to inside the learner. But a facilitator of learning is described by Pike (1989:67) as "[I]deally you are the best kind of teacher – a facilitator of insight, change and growth, who teaches that answers come from within." Facilitating learning constitutes an inside-out paradigm and therefore the direct opposite of current education paradigm which is founded on the conviction that potential is already present inside the learner and it has to be fully utilised to live a life of extraordinary quality outside. Heidegger is very explicit in this regard when he says: "The real teacher, in fact, lets nothing else be learned than – learning. His conduct, therefore, often produces the impression that we properly learn nothing from him" (Armstrong, 1991:48). Since the learner's learning is the only thing that qualifies education as education, and since only learners are involved in their own learning and that no one can do it for or on behalf of them, there are only two things a facilitator of learning can do:

a. To get the learners to start learning – to initiate learning
b. To ensure that the learners keep on learning until the highest possible quality of learning has been achieved – to maintain learning

A. INITIATING LEARNING

Since the learning required to transcend the restrictions imposed on us by an increasingly uncertain emerging future is very specific, we need recognise its corresponding theoretical context. Von Glaserfeld's (1984:37) states that "[k]nowledge is not a transferable commodity and communication not a conveyance". According to constructivist epistemology, knowledge is not passively received either through the senses or by way of communication, but it is actively constructed by the individual through interactions with the environment (Heyligen, 1997). It is remarkable how constructivism has impregnated the current discourse in education and how it seems to be significantly contributing to our understanding of epistemology (Botella, 2004).

Radical constructivism as thé conceptualisation for education (Von Glaserfeld, 1995:7) adds that the function of cognition is to organise the experiential world, not to discover an objective ontological reality. Piaget (1945:113) explains as follows: "The mind begins neither with knowledge of the self nor knowledge of things as such, but with knowledge of their interaction…" The models of reality constructed in this way serve as the basis from which to subsequently interact with the environment. A

selected model's reliability to provide the desired interaction acts as a coherence selection criterion that prevents constructivism to deteriorate into absolute relativism. However, since "it would be a miracle if the conceptual structures in different heads were the same" (Von Glaserveld, 2001:163), the criterion of consensus between different cognitive structures of individuals has to be activated because knowledge is constructed in a social context (Wortham, 2001). The knowledge construction process is therefore radically socio-constructivist.

In addition, Gergen's (1991) social constructionist perspective generated a growing interest in the relationship between constructivism and postmodern thought. Some authors explicitly explored this relationship and confirms the link (Tarnas, 1991; McNamee and Gergen, 1992; Kvale, 1992; Neimeyer, 1993; Polkinghorne, 1992; Novak, 1993). In addition, the most recent developments in experimental psychology, cognitive science, artificial science and neuroscience exposed an understanding of knowledge which "turns much of our conventional corporate and educational wisdom on its head" (Claxton 2000:10). The biological, physiological and neurological evidence regarding the natural functioning of the brain (Smilkstein, 2003) correlates with radical socio-constructivist epistemology.

How is this learning best initiated? Since learning is the meaningful construction of something by the learner him/herself which the learner did not have before it also active, creative learning. The necessity of this kind of learning has been realised from the earliest of time by Plato, Socrates, Montaigne, Milton, Franklin, Rousseau, Jefferson, Newman, Spencer, Dewey, Whitehead and many others (Foshay and Foshay, 1981:3). Such learning is initiated by the activation of critical, reflective thinking (Dewey, 1933). One does not learn to think critically and reflectively through instruction or teaching but being placed in situations where one cannot else but think critically and reflectively (Claxton, 1999:121-133). Such thinking presupposes thinking about thinking which, in turn, implies a problem to solve. (Hullfish, and Smith, 1961:212): "Where there is no problem, where no snarl appears in the normal flow of experience, there is no occasion to engage in thought …[I]t is important that teachers understand the intimate relationship between problem-solving and thought". In fact, educationists, both old (Smith, 1966:175) and contemporary (Hargreaves, 2003:xviii; Boekaerts and Minnaert, 2003:78; Vermunt, 2003:111-114, 116, 118-121, 123; Steinkueler, Derry, Hmelo-Silver and DelMarcel, 2002) eludes to the necessity of creative problem solving to be the core of the curriculum itself.

But what is the kind of problem required to fulfil the educational aim. As early as 1929, Whitehead (1929:16) has stated: "Let the main ideas which are introduced into a child's education be few and important, and let them be thrown into every combination possible. The child should make them his own, and should understand their application *here and now* in the circumstances of his *actual life*" [own emphasis]. Dreyden and Vos (1999:26) say: "Use the real world as your classroom, and to learn it, do it". We now know that the notion to first teach the basics (theory) and then have learners apply it (practice), is fundamentally flawed on three accounts. First: Neuroscientifically, rational knowledge (what/theory) and practical know-how (how/practice) is located in completely different areas of the brain. It is through the direct immersion in experience – the natural learning ability of the brain – that practical know-how is developed in order to construct meaningful rational knowledge. If the neural networking is forced – because it is not natural – in the opposite direction, the practical know-how is always impeded and accumulatively restricted by the efficiency of the original transfer of the rational knowledge (Claxton, 1999:117-118, 331-333; Smilkstein, 2003:101-102; Van Merriënboer and Paas, 2003:8-12). Second: Psychologically, the learning environment is of crucial importance to enable the learner to utilise what he/she has constructed to subsequently do something creatively new. If the learning environment does not constitute a real life problem to be solved right now because it is impacting the quality of living life right now, it would be "so remote from real context and real concerns … that no transfer takes place" (Claxton, 1999:209). That is why Claxton (1999:210) advises that only if it is impossible in a particular circumstance to engage in real life, the learning environment should at least simulate it as closely as possible! Third: Practically, real life is holistic and the problems it presents are holistic problems which require the engagement of all human faculties to solve it to encounter our interconnected wholeness (Clark, 1997; Waldrop, 1992; Flake 2002; Capra, 2004).

Learning should therefore be initiated by a real life problem that the learners need to solve themselves.

What should the nature of such a problem be? Much of the nature of the required real life problem has already been implicitly revealed. If the problem is aimed at fully utilising human potential to solve it, then the problem must be challenging enough to do so. In fact, the level of the challenge has to exceed the current ability of the learner to such an extent that doubt about being successful might even occur. However, the intrinsic reward of improving the quality of life when the problem is solved would be the primary motivator. But to solve this problem need to require the complete immersion of the entire human being in order to acquire a new order of consciousness. Authentic learning "is often hard and protracted, confusing and frustrating … Much learning involves exhilarating spurts, frustrating plateaus and upsetting regressions … Even when learning is going smoothly, there is always a possibility of surprise, confusion, frustration, disappointment or apprehension – as well, of course, fascination, absorption, exhilaration, awe or relief" (Claxton, 1999:15-16). Because learning is "intrinsically an emotional business", always creates a peak experience of joy and self-fulfilment at achieving success (Csickszentmihalyi, 1991). And even if the problem itself is not solved, because the attempt was a holistic endeavour, the process inevitably enhanced other aspects of the quality of the learner's life, constituting success and subsequent joy and self-fulfilment in that regard.

Although life presents us with a series of problems, all life is not a problem, and besides problems, life always provides opportunities to improve its quality. We could therefore conclude that ***learning is initiated by a real life challenge, either in the form of an existing problem to be solved or an opportunity to improve the quality of life***.

Initiating learning is also the only aspect of FL that can be designed because it is determined by all the initiating actions of the FOL. Maintaining learning cannot be designed because it is determined by the response actions of the learners on the initiating actions of the FOL. What would be the required first action of a facilitator of learning?

1. LEARNING TASK DESIGN (LTD)

To enable the FOL to initiate learning, he/she needs to very thoroughly and carefully consider the format of such an event since it needs to constitute real life, of which the world of work and what it demands in real life is crucial, since between 60-80% of our lives are occupied in that domain. "Learning tasks nicely fit the ideas that are prevalent in the world of work. Learning tasks are concrete, authentic and meaningful real-life experiences that are provided to learners" (Van Merriënboer and Paas, 2003:9). A Learning Task (LT) constitute authentic real life in its uncompromising holistic complexity. A LT, therefore, is pivotal in education and provides a powerful learning environment aimed at complex holistic learning as would real life demand it (Van Merriënboer and Paas, 2003:9). De Corte (2003: 21-33) describes powerful learning environments as environments that best enhances transfer of learning. Van Merriënboer and Paas (2003: 3-28) reports that real-life has become the dominant consideration in designing powerful learning environments. In fact, they say that "learning needs to be situated in problem solving in real life, authentic contexts" (Van Merriënboer and Paas, 2003: 5), where the environment contains ill structured information in which no answers are embedded, but it requires total engagement of the learner through meaningful experiences which enables "the learner to learn the ways of knowing of an expert" (Van Merriënboer and Paas, 2003: 5). Claxton (1999: 307-311) echoes the same notion and adds the crucial importance that learning to learn (metalearning through metacognition) includes the self-discovery of the tools (algorithms) to solve problems and the self-discovery of the relevance of the application of such tools according to the natural functioning of the brain (Claxton, 1999:198-211). De Corte (2003:25) suggests that the acquisition of such competencies requires that learners be confronted as much as possible with demanding real life challenges in authentic contexts that has personal meaning for them which they need to resolve personally as well as through interaction and collaboration with others.

A LT, therefore, is a demanding real-life challenge that the learners have to resolve by themselves. This challenge needs to compel them to stretch themselves beyond their abilities and capabilities. It

has to be a challenge that demands that learners engage in living the reality of real life right now and take responsibility for doing so, and thus fully utilise their potential to become joyous, self-fulfilled human beings.

But the LT must first be designed before it can operate to initiate and subsequently maintain learning. The operating concept "design" is used because of its root being that something is creatively constructed from "nothing" – as opposed to the concept "planning" which indicates that everything needed is already available and simply needs to be ordered appropriately. LTD is therefore a very demanding and highly professional responsibility that needs to be done with deep consideration and great care.

LEARNING TASK DESIGN (LTD)

1. MINIMUM REQUIREMENTS

There are minimum requirements for reporting LTD according to the Department of Education. Institutions have and could develop their own LTD form and format. However, the minimum requirements to be included in such a LTD form and format are the following:

a. Learning area/subject/discipline
b. Learning level or phase.
c. Learning outcomes (LO's) from the specific learning area/subject/discipline/phase.
d. The associated assessment standard (AS) for each LO.
e. Time allocated.
f. Class organisation.
g. Resources.
h. Assessment methods tools and techniques that will be used.

What follows are guidelines for LTD and what is expected to be contained in a LTD.

2. GUIDELINES FOR LTD

The headings that follow are the headings to be used in documenting the LTD

- **PERSONAL DETAILS**

Indication of full personal details: Name, student number, phase in which qualification is sought to facilitate learning

- **LEARNING PROGRAMME AREA/SUBJECT/DISCIPLINE**

Specify the area of specialisation in terms of a learning programme or learning area/subject/discipline

- **SPECIFIC LEVEL OF LEARNING**

Specify the level of learning (ie. which Grade, certificate, diploma, degree)

- **LEARNING OUTCOMES (LO'S) AND CORRESPONDING ASSESSMENT STANDARDS (AS'S)**

A careful *selection* of the specific LO's to be achieved with its corresponding AS's within the area of specialisation at the particular level of learning.

- Consult the NCS
- Identify those LO's and corresponding AS's that should be incorporated in all LT's
- Identify those LO's and corresponding AS's you particularly want to have learners achieve in this LT
- Copy all these LO's and corresponding AS's – their numbers AND their FULL descriptions – from the NCS and insert it under this heading

❑ **THE CHALLENGE**

TO DESIGN THE CHALLENGE, THE PROCESS INDICATED BY a) TO e) THAT FOLLOWS IS RECOMMENDED

a) ***To obtain a basic challenge:***
- Identify from the particular LO's and corresponding AS's you want learners to achieve in this LT and the knowledge areas, and the core knowledge and concepts in the NCSG any issue in real life.
- Generate as many aspects as possible about this issue.
- Identify all those aspects about this topic that are real life challenges: problem areas in real life or areas in real life that provide the opportunity to improve the quality of life.
- Choose from those identified challenges, five of the most important, urgent, prominent, pressing, exciting or rewarding.
- Select from the chosen 5 challenges, the one with the most prominent role or function in the life of the learners right now (or that needs to be addressed right now to prevent future complications)
- Determine the challenge the learners would most likely be able to actually experience in real time
- Determine whether the challenge will be legal, safe and practical for learners to experience.
    - If it is not safe and practical for learners to experience, then determine the next best challenge or the one closest to experiencing it in real time.
    - If it is safe and practical for learners to experience, then formulate this basic challenge in one sentence in the form of a question.

b) ***To obtain the specific challenge:*** The basic challenge should now be made specific by exploring and studying all available relevant material on it. Give correct, accurate, and full bibliographical details of all the resources within the particular learning area of specialisation that you have consulted:
- *authoritative resources* (official documents, scientific textbooks used in universities, technikons, and colleges, scientific journals and electronic media and multimedia software on the problem) which supplies the scientific soundness, correctness and accuracy perspective;
- *popular resources* (journals and periodicals and electronic multimedia software on the topic which are not so scientifically inclined) which supplies the context in a wider perspective;
- *general resources* (magazines, daily newspapers, radio, TV, and multimedia software as well as the internet) which displays the reality of daily living;
- *institutional resources* (prescribed textbooks for the learners and other electronic multimedia software).

By doing this, the facilitator of leaning is able to determine the scope, possibilities, limitations and implications of the problem or improvement as reflected in everyday life for which we are preparing our learners. This elaborated problem should now be categorised in the following components:

- *WHAT* – content: core knowledge and concepts (facts, concepts, principles, laws, rules, etc), which represents the *meaning that has to be constructed* by the learners. It must be in structural form (like a concept map, diagrammes and sketches) and it must be complete.
- *HOW* - competencies: abilities, skills and techniques, which represent what learners will do, which would also function as a demonstration that the assessment standards have been met.
- *WHERE* - relationships: conditions under which the learners will execute the leaning task which represents the *authenticity* of the learning.

c. ***To obtain the final challenge:*** The specific challenge has to be transformed into a fully-fledged final challenge. This is done by answering the following question: How will I challenge, evoke and elicit learners to establish the necessary relationships with what is to be learned, so that they are compelled to implement the appropriate competencies, in order to construct the required meaning themselves: discovering and understanding the material in such a way that they are able to use it do something creatively new. The *popular* and especially the *general* resources will assist you in trying to find an answer to the question. To construct such a problem within the context of a learning task, is the most demanding aspect of LTD. To know exactly what the problem in LT context is, is therefore of crucial importance. The contributions of (Barrows & Tamblyn 1980:18), Claxton (1999), Slabbert (2000) and Van Loggerenberg (2000), can be summarized as follows:

- It is an unsettled, puzzling, unsolved, challenging, exciting issue that needs to be resolved.
- It is an unanticipated event that disrupted the normal cause of matters.
- It is a situation that is unacceptable and needs to be corrected.
- It is something for which there is currently no ready-made solution – it is therefore original and new.
- It is not offered as an example of the relevance of prior learning or as an application of knowledge already learnt.
- It is encountered for the first time in the learning situation.
- It serves as a focus or stimulus for the use of creative problem-solving skills.
- It serves as a focus or stimulus for the search for and study of information or knowledge needed to understand the cause of the problem and what it entails.
- It serves as a focus or stimulus for the search for and study of information or knowledge needed to find out how the problem might be resolved.
- The required skills for resolving the challenge have not yet been acquired.
- The effect of a problem is that what one needs to do next is always uncertain.
- It claims the complete personal involvement of the learners because the learners themselves really experience the challenge in real time – right now!
- It is both important and necessary to be resolved urgently through immediate action.
- It is something that will impact the enhancement of living their lives right now when they have solved the problem.
- It is something that needs to be resolved right now because the discomfort or excitement in experiencing it is too much to bear.

d) *Consider the following criteria for a challenge*

- It has to be a challenge in life context
- It has to remove the boundary between the educational institution and reality
- It has to be new, original and creative in nature
- It has to be credible
- It has to be a challenge for the learner
- It has to claim complete personal involvement of the learner
- It has to challenge learners to stretch themselves beyond what they believe their capacity is
- It has to compel learners to learn spontaneously
- It has to launch learners into a peak experience of joy and self-fulfilment

e) *Identify the category of the LT*

Since current curricula may not support only real life LT's, it is important to recognise what alternatives are available. There are four categories of learning tasks and the categories are also arranged in hierarchical order, which means that all effort has to be exerted into designing a learning task in the first category. Only when that becomes really impossible, should the next category be considered and so on. Only when the challenge within another category is much higher or the nature of the challenge demands it, is a deviation from the hierarchy allowed. These categories of learning tasks have been identified, based on the foundational work of two of the "mothers" who integrated drama as learning in education, Heathcote (1991) and O'Neill (1995) as well as other experts (Wagner, 1999; Andersen, 2004; Taylor and Warner, 2005):

- *Real life learning tasks* where learners operate in *real life* as it is and where the outcome of the learning task makes a direct positive contribution to society and the environment. Real life learning tasks are usually very *entrepreneurial* in nature. If your practice focuses on educating learners for a particular job or profession, then experiencing (really doing) this job or profession in real life is what this category of learning tasks portrays.
- *The world of work learning tasks* are learning tasks situated in the world of *work*. Any one or more jobs related to the learning task at hand are selected for the context, or, if your practice focuses on educating learners for a particular job or profession, then that job or profession will be the only context. These jobs are simulated and the learners and facilitator of learning are usually in role-play: They are portraying characters involved in or associated with the particular jobs.

- *Fictional or hypothetical learning tasks* are learning tasks which transcends the here and now into the imaginary and fantasy worlds. They are learning tasks situated in another place and/or in another time. Futuristic learning tasks are especially important in this category, in, not only anticipating the future, but more urgently, creating the future. These situations will also be simulated and role-play will be evident.
- *Pure play learning tasks* are learning tasks which are structured in the form of games which might have very fixed rules or very loose ones. The rules might be given as conditions or limitations by the facilitator or the learners themselves may create them.

d) *Consider the following possible formats of LT's*

There are many life contexts or formats within which your learning tasks can be set. The following are some formats or ideas. The list is nowhere near complete but only suggests some ideas.

Anecdote - story Analogy – "the same as" Carnival Case study Ceremony Conference Commercials - TV, Radio Competition - various Court case Dance Design Detection Discovery Drama Exhibition Festival Fieldwork Film making Forum Game - existing or devised: high energy activity with rules to achieve a specific outcome Interview Interrogations Invention	Meeting Mime Narration - storytelling Obituary - outline of someone's life Portrait making - learners making a still image or photo story which represents something (eg before/after) which can come alive to tell a story Presentation Production Project Promotion Re-enactment Research Role-play - focus on roles to be acted out in a particular situation and switching of roles Scenario Seminars Simulations - controlled representations of the real world but the facilitator does not take a role War Writing

e) *Consider the following items to spark off action*

Of importance is to get the LT into action. There are many items in life context, which may do so. The following are items that might spark off such action. Again the list is not complete but suggests some ideas.

Costumes Documents - antique, past, present Files - with information Journals Letters Log books Messages Models Movement Music	News Newspapers Objects - single or collection Photographs Pictures Poems Script Sounds Slides Video or film

e) *Consider the following frameworks in which to design your LT*

Your learning task should also be framed into one or the other life context. There are many frames into which your learning task can be set. The following are some suggestions.

FRAME	EXPLANATION
Time	Past, present, future
Perspective	* Living in the present, looking at the past or the future * Living in the past, looking at the present or the future * Living in the future, looking at the past or the present
Age	From unborn to past the grave
Social status	From "peasant" to "king"
Role	Responsibility, expert, novice, person, object, event, frame of mind, position
Reality	Real, hypothetical, fictional, imaginary
Communication	Verbal language (slang, dialect, code) non-verbal language, no language
Locality	Here, elsewhere, anywhere

AS A RESULT OF THE PROCESS ABOVE YOU ARE NOW ABLE TO FURTHER DOCUMENT YOUR LTD

- **CATEGORY**

Specify the category of this specific LT and why this category was (one of the four under categories of LT's)

- **AUTHENTIC LEARNING CONTEXT**

Creating an authentic learning context is of extreme importance (Heathcote, 1991; O'Neill, 1995; Wagner, 1999; Taylor and Warner, 2005). However, it must be emphasised that it is establishing the authentic context in the minds of learners (inner psychological and emotional environment) that is of crucial importance and this can be done without any physical manipulation of the outer environment – but this obviously needs careful consideration skilful expertise. A complete description with accompanying sketches where necessary of the authentic learning context in which the learning task will be executed should contain the following:

- How the learning environment will be organised to create the most authentic learning context or atmosphere.
- Specifying the role or function of the FOL, learner, and any other participant. What are the roles of the learners if any particular role will be played?
- Specify what kind of identification (clothing, nametag, props, etc.) will the role-players be identified with, if any?
- Supply an inventory of all the resources (as authentic as possible) the learners will be using (real objects, models, audio-visual, printed materials, electronic materials, computer software, etc) and what it will be used for.
- Supply an inventory of all the materials and apparatus (decorations and props, identity tokens for things and to indicate roles, costumes, etc) to be used and for what they will be used to create the most authentic learning context or atmosphere.

- **PRESENTATION**

A demanding real life challenge (problem existing in real life or a opportunity and desire to improve the quality of life) needs to be formulated in its final form exactly in the format and way in which it will be presented to the learners. It has to adhere to the following criteria:

a) It has to provide the entire framework of the problem to enable learners to work completely independently from the FOL.
b) It has to state the challenge clearly and unambiguously.
c) It has to require learners to plan before they start working: first individually, then cooperatively (See metalearning and cooperative learning later).
d) It has to require learners to resolve the challenge: first individually, and then cooperatively.
e) It has to require learners (implicitly) to produce end product outcomes.

- **DOCUMENTATION**

The learners need to receive the challenge in an abbreviated form, but containing the essence and adhering to all the criteria as required in the presentation. This may be done through a work document. A work document may vary according to the nature of the challenge, from a document containing the challenge only, to a very comprehensive learning package containing the challenge, questionnaires, learning materials, etc.

- **END PRODUCT OUTCOMES**

Supply the end product outcomes (at least one possibility) as would be expected from a learner who has executed the LT excellently.

- ✓ The answer to the problem or the resolved challenge as a product in at least one of the following forms:
  - ➢ a physical object that has been produced
  - ➢ a decision that has been made
  - ➢ a process that has been generated
  - ➢ a service that has been provided

  This will represent the product of learning in terms of doing something creatively new

  AND
- ✓ How the problem has been solved – the process or procedure. This will represent the process of learning through the competencies the learners obtained and employed.

  AND
- ✓ A construction of all the core knowledge and concepts acquired (in the form of a concept map) and how everything is related regarding the solution to this problem. This will represent the content, which implies that the learners are actually writing their own (but much more relevant) “textbooks”.

FOLLOWING ARE SOME OF THE LAST ASPECTS THAT SHOUL BE PART OF THE LTD BUT IT CANNOT AS SUCH BE RECORDED

a. Collecting, making, buying everything needed.
b. Preparing the learning area with everything in it.
c. Testing everything.

A designed LT has no use unless it is put into practice. This means that your designed learning task has to be put into operation. This process is called **Learning Task Operation (LTO)** which contains the entire further process of facilitating learning from this point forward. The second required action of initiating learning is learning task presentation by the FOL

2. LEARNING TASK PRESENTATION (LTP)

Even the best designed LT may fail badly when it is presented which may cause the whole LTO to collapse. Your LTP is therefore of major importance for the success of the LTO. It is your LTP that requires artistry and creative skill that again focuses on the uniqueness and professionalism of facilitating learning. That is why education is often referred to as an art. The LTP may also include some activity where the learners have to identify the challenge themselves instead of the FOL presenting them with a challenge. Facilitating learning through LTP is the first test of the facilitator of learning of true professionalism in educational interaction with learners. LTP needs therefore to adhere to very demanding requirements (Heathcote, 1991; O'Neill, 1995; Wagner, 1999; Andersen, 2004; Taylor and Warner, 2005):

a. Creating a totally conducive atmosphere

The verbal presentation and everything that accompanies it has to work together to create the most conducive atmosphere in establishing the learning context. As has been indicated before, effectively executed, the verbal presentation alone may be sufficient to fulfil this aim because "it is all in the mind" and if the verbal presentation can touch the mind in such a way that it creates the appropriate emotional inclination, the creation of the atmosphere was sufficiently conducive.

b. Establishing roles and functions of the participants

Whilst creating the totally conducive atmosphere is "setting the scene" the immediate need for the participants are their roles and functions in the situation because it immediately focuses attention to the presentation to establish expectations and anticipate possible actions.

c. Presenting the real life challenge

Although the real life challenge should be presented authentically – as real life would present it – because this happens in education it has to be presented complying to the following criteria:

(i) Clarity
The challenge to be resolved has to be absolutely clear to the learners so that they will not be distracted into doing something that would not resolve the challenge at hand because that was the aim of this particular learning period.

(ii) Importance
The learners need to experience the importance of resolving this real life challenge. Even more importantly, they need to experience why it is important that they, and no one else, need to resolve the challenge.

(iii) Urgency
The learners have to be convinced that they need to resolve the challenge right now and not any later.

(iii) Action
The end of the presentation has to compel the learners straight into learning action.

B. MAINTAINING LEARNING

Obviously, when the learners turn into learning action, initiating learning has ended and the responsibility of the FOL is now to ensure that the learning of the learners is maintained. The aim of maintaining learning is to improve the quality of learning until the highest possible quality of learning has been achieved which means that the learners were compelled to fully utilise their potential.

1. Learning task execution (LTE)

After LTP the LT need to be executed. LTE is done by the learners only, but it is facilitated intentionally and intensively by the FOL to continually improve learning quality which Torrance (1991:225-233) refers to as keeping it going and continually deepening expectations. This is the whole purpose of LTO: The learners need to resolve the challenge through which they fully utilise their potential and become lifelong learners. They do this ***first*** individually and ***then*** cooperatively.

a. Metalearning (ML)

The learners must first resolve the challenge individually and independently, so that each learner can take control over and responsibility for his/her own learning. This is the only way in which the learner will become an active, effective, independent, lifelong learner. The LT needs to require the learner to plan, execute, monitor and assess his/her own learning. This is based on metacognition introduced by Flavell (1976:88): "'Metacognition' refers to one's knowledge concerning one's own cognitive processes and products or anything related to them…". Spring (1985:291) explains that "[m]etacognition is the ability of learners to know how they know and regulate the learning process constantly" and Ford (1981:360) say that metacognition is "a prerequisite for learning how to learn effectively" and Flavell (2004) concurs. Many contemporary experts also integrates metacognition and its skills with effective learning in powerful learning environments (De Corte, 2003:23; Lethinen, 2003: 36; Vermunt, 2003:121; Vosniadou and Kollias, 2003: 190; Keer and Verhaeghe, 2003: 227; Kuhn and 2004; Smith, 2005). Biggs and Telfer (1987:185) brought metacognition directly into the educational field which he called metalearning (ML), and in the following year it was fully established as an educational theoretical framework (Slabbert, 1988). ML is a continuous reflection of the learner on his/her own learning process through asking metalearning questions and answering them to improve the quality of learning. Following are the required metalearning strategies with their accompanying questions:

(i) Planning own learning
What is this all about? What do I know about this? What does this relate to? Do I know enough about this? Have I read it carefully and fully? What are the most important parts? How do the parts relate to each other? How does this relate to what I already know? Does this make sense? What will I have to find out for it to make sense? What am I required to do? What will I have to do in order to complete the task? How do I see the task?

(ii) Executing own learning
That which has been planned as a result of answering the planning questions has to be executed as planned. However, as the execution of the learning process progress, The learners should continuously ask questions to improve the quality of the learning process.

(iii) Monitoring own learning
How does this new knowledge compare to what I previously knew or predicted? Do I have to change my understanding of what I previously knew? Do I understand what I am doing? What will happen if ... ? How does this relate to ... ? How could this be? Why does this happen ? When does this not apply? Is this the best way of doing it? How am I doing? Does this seem correct? What should I do next? Am I checking all possibilities? Where will this lead me? How do I feel about this? Have I completed this fully and carefully? What else needs to be done?

(iv) Assessing own learning
How could I have done this even better? Do I fully understand this? What do I have to do to fully understand? Do I understand enough to justify stopping? How does mine compare with others? How do I feel about this? How can I use this in future? What did I learn from this? When will I need to do something similar? How do I feel now?

This process compels the learners to implement thinking skills and creative problem solving. But most importantly, metalearning serves as the instrument through which to acquire the fundamental intrapersonal life skills that is lacking so severely in first time employees. These life skills cannot be taught or learned – they are a consequence of living life fully because they form the character ethic of the human being (Covey, 1992: 5-11). From the many resources about life skills, those that fundamentally constitute intrapersonal life skills are the following (Slabbert, 2000:224-227):

LIFE SKILL	DESCRIPTION
Self-confidence	Feeling able to do it.
Motivation	Wanting to do it.
Initiative	Moving into action without any prompting.
Effort	Willing to work hard.
Perseverance	Keep on going no matter how difficult it is.
Common sense	Making the best choices out of many possibilities.
Responsibility	Doing what is right and carry the consequences.
Independence	Doing it yourself.
Joy	To be happy.
Love	To care ultimately for you and everything around you.

b. Cooperative learning (CL)

According to the maturity continuum manifested in the natural law of evolutionary development (Covey, 1992:46-52), we begin life as infants totally dependent upon others. Over time we become more independent, inner directed and self-reliant. Very soon, however, the reality of life by its very interdependent nature dawns on us as the highest human value because "[n]one of us is as smart as all of us" (Johanson and Johnson, 1990:107). "Growth, change, and ultimately evolution occur as individuals, organisations, and society increases the depth of their relationships by continually broadening and strengthening their interdependent connections" and our brains are especially hardwired for this purpose (Blakemore and Frith, 2005). The foundation of life and living it, is relationship (Wheatley, 2003) and learning through this fundamental life principle is not only necessary, it is inevitable (Alderman and Milne, 2005). Cooperative learning (CL) takes place when learners in small groups cooperate to learn with the exclusive purpose to increase the quality of each other's learning in order to fully utilise their individual potential (Kagan, 1992:6; Johnson and Johnson, 1990:110). CL is not group work because the most distinctive aspect about CL is the fact that it requires the following demanding criteria (Cohen, 2004) to be characterised as cooperative learning and to qualify as an instrument to improve the quality of learning (Jacobs, Power and Loh, 2002, McManus, 2005):

(i) Optimal group size
The most effective group size for cooperative learning is 4 because it offers the smallest number of members with the highest number of communication lines as possible.

(ii) Heterogeneous groups
Groups should be heterogeneous in every respect: ability, sex, culture, etc.

(iii) Positive interdependence
The LT has to be designed in such a way that individual members have to be dependent upon another for the group to achieve success.

(iv) Individual accountability
Although each member of the group may be working on a separate aspect of the LT, each member has to be fully aware of what all the other members are doing and how they are doing it because he/she may be assessed on any aspect of the LT and his/her contribution should be representative of all members to be graded as a group effort.

(v) Promotive interaction

It should be clear that the previous criteria compels interaction between members, but it is promotive interaction because the interaction aims at critically assess the quality of all member's learning.

(vi) Assessment of cooperation

Frequent and regular assessment of the quality of members' cooperation has to be done in order to eliminate harmful and enhance conducive cooperative behaviours.

Only through cooperative learning will the learner acquire the interpersonal life skills. What is of crucial importance is that metalearning has to precede cooperative learning, in that the LT or predetermined aspects of it, has been completed by the individual. Only then will the individual have had the opportunity to acquire the intrapersonal life skills and simultaneously constructed a meaningful contribution that he she can present to the group. Only then will cooperative learning fulfil its aim. In the same way as the intrapersonal life skills, the interpersonal life skills cannot be taught or learned – they are also a consequence of living life fully because they form the character ethic of the human being (Covey, 1992: 5-11). From the many resources about life skills, those that fundamentally constitute interpersonal life skills are the following (Slabbert, 2000:239-243):

LIFE SKILL	DESCRIPTION
Humanisation	*How do I see you?*
Communication	*How do I interact with you?*
Dealing with feelings	*How do I react to you?*
Justice and forgiveness	*How do I want you to react to me?*
Love	*How do I care ultimately for you?*
Leadership	*How effectively can I lead you to fully utilise your potential?*

LEARNER EMPOWERMENT

Metalearning and cooperative learning result in learner empowerment. For this to happen, it demands from learners the following new roles and responsibilities:

a. Taking responsibility for their own learning to maximise his/her potential and acquire the competencies necessary for living in a continuously changing new world order, and consequently becoming empowered to do so. It means to become ultimately versatile.
b. Controlling his/her own learning to become versatile. This means that the learner needs to possess the vastest array of learning strategies possible. Then and only then will the learner be able to *control* his/her preferences (learning style) and motives (learning approach) because he/she can make *choices* to suit the requirements of the learning task. If the learning task, for instance, requires the learner to recognise the chemical elements depicted on the chemical containers in order to conduct a chemical experiment, the way in which to accomplish the task would be to memorise names and respective symbols of the chemical elements on the periodic table - a typical surface learning strategy which suits the requirements of the learning task perfectly. There is no need for trying to find the rational or meaning behind the philosophy of the names and respective symbols of the chemical elements - a typical deep learning strategy. If however the learner only had the latter strategy in his/her repertoire, the learning task may be accomplished eventually, but in a totally ineffective way. Because the learner had a repertoire of learning strategies available and because the learner can discern between them to choose and select the most effective, the learner is in full control over his own learning and consequently empowered to determine the quality of his/her own learning. If however, the learner discovers *any* deficiency in his/her armour to effectively complete a learning task, it is the *learner's* responsibility to rectify the situation and *acquire* what is necessary, whether it is information or knowledge or a competency. Again this manifests the learner's control over his/her own learning and his/her empowerment to be a lifelong learner.
c. If additional information is needed to acquire some knowledge to solve the problem (learning task) at hand, it is the learner's responsibility not only *to **acquire** that knowledge or information* through the abundant resources available (not least of all the information technology), but also *to **find** those relevant resources* needed. It must be emphasised that the facilitator is not and should never be a source of information as facilitator. However, he/she might serve as a source of information or knowledge only if and when he/she is not acting as facilitator, but having the learners learn and experience the variety of resources available: The facilitator might decide to take the role of some individual who might have the information or knowledge available if such a person is not otherwise accessible. In this way the learner does not become dependent upon the facilitator but learns the many possibilities of different resources and at the same time the learner learns to master many other valuable competencies needed in life, for instance, the competency of interviewing. This makes it possible for learners to effectively access and acquire the most recent knowledge (contents and structure) immediately when it becomes available. A personal experience should be recorded here because it illustrates our ignorance of learners' abilities. In the one situation, the learners of a grade 9 class had a "practical" on roots and stems of plants and the different kinds of each. This is work that has been *taught* since grade 4 and repeated virtually every year with a little more detail. In spite of this repetition of *knowledge or information transfer* as well as the fact that it has been taught just the previous week, the learners doing the practical had difficulty answering direct knowledge reproduction questions and they could not with any certainty identify the different roots on the plants they were supplied with. In another situation, which was witnessed within days of the first, a learner exhibited the material she gathered and compiled for a project. The topic was exactly the same: roots and stems of plants and the different kinds of each. She had done *everything* on her own. She had studied the resources available, collected the material, wrote up a report and assembled her exhibition. She could not only answer knowledge *production* questions, but could easily on request identify different roots/stems. She also demonstrated her thinking ability when confronted with difficult questions - she demonstrated the knowledge of what was expected from the grade 9 learners and even beyond. Most astonishing was the fact that there was nothing special about this learner, in fact, she was typical of the very average learner in a very average socio-economical area - but she was in grade two. She had therefore never encountered

this work before. This illustrated that it cannot be tolerated to waste valuable learning time (class time) to transfer knowledge because learners are able to and should

(according to the critical outcomes) collect, analyse, organise and critically assess such information or knowledge through other resources available not needing to wait for someone or even the syllabus to reveal or expose it.

d. If *drill* and *practice* are needed to acquire a specific skill which is necessary to solve the problem, it is the learner's responsibility to *do* the drilling and practicing - through instruction manuals or other resources from which the learner will be able to work independently and until the necessary proficiency is obtained. The facilitator cannot, in any case, do the drill or practice for or on behalf of the learner. The learner has to take responsibility for this and no valuable quality learning time ("class time") should be spent on this. This makes it possible for learners even to immediately drill and practice the most recent required competencies when they become known, not needing to wait for someone or the curriculum to demand it.

2. Learning task feedback (LTF)

Learning is maintained through the principle of continuous feedback. Throughout the learning process, be it individual or cooperative, the FOL needs to make certain that the learners keep on learning. Every Feedback (FB) action of the FOL during maintaining learning has to cause the learners to become more independent. That is why the FOL realises that he/she should not give answers to learners' questions and/or become a source of information. This will make the learners dependent and will prevent them from maximising their potential.

The FOL has to observe all the learning activities very carefully during maintaining learning, to be able to FB in the most appropriate way, and so ensuring the best possible quality of learning. In this, the FOL is relentless: He/she would not stop with the actions of facilitating learning described here until the highest possible quality of learning has been achieved by the learners themselves. He/she would also not stop with these actions until the learners have made sure that what they have learned is, for the particular time period and the level they operate on, scientifically absolutely correct.

Maintaining learning cannot be designed or planned for because it depends entirely on the actions of the learners, and those are unknown until they actually occur – however, maintaining learning can and should be thoroughly anticipated. That is why maintaining learning is such a highly skilful, demanding and professional facilitating learning action.

a. Emotional encouragement and support

If the learners are learning well and the quality of their learning is sufficient, the FOL gives emotional encouragement and support, by saying things like: "You are really doing well" (encouragement); or "I know you can do it" (support).

b. Asking clarification

If the FOL observes that the learners are getting off track or the quality of their learning is not good enough, or suspects that this is the case, he/she has to determine exactly where the learners are. The FOL will ask questions such as: "What are you doing?", "Why are you doing this?" or "What do you want to do next?" The FOL seeks information to clarify the position of the learner. This is the only case when the FOL obviously wants an answer and waits for it. But this will always be followed by a challenge for learners to metalearn.

c. Challenging learners to metalearn

(i) Reverting learners' questions back to learners

When learners request help of any kind from the FOL through asking questions, the FOL has to return the question back to the learners by asking questions like: "What do you think?", or "What would you do?".

(ii) Requesting reflection from learners for increased quality of learning

Whether the FOL has detected insufficient quality of learning or whether the learner has made it known somehow, the purpose of the FOL is to have learners reflect on what they did, assess it and improve on it. That is why the FOL will ask the questions and then leave without getting an answer. The FOL will ask questions such as:

- ✓ Have you thought of everything?
- ✓ Have you considered all possibilities?
- ✓ Is this the best way of doing it?
- ✓ How many more can you find?
- ✓ Do you understand what you are doing?
- ✓ Do you understand why you are doing it?
- ✓ Is this enough?
- ✓ How will you improve this?
- ✓ How sure are you?
- ✓ How will you make sure?
- ✓ How well do you think you did?
- ✓ What is the meaning of this for your future?

(iii) Reference to resources

If learners cannot solve the problem in spite of previous actions from the FOL, he/she should refer learners to resources where they might find some information to help them, by asking questions such as: "What do you need?" and "Where will you find what you need?" Obviously the FOL will have made provision for such a possibility and would have made sure that the resources are accessible in the most realistic and appropriate way.

(iv) Auto-education

If learners are still at this point seriously lacking in knowledge and/or skills to enable them to solve the problem, the FOL, as a last resort, will have made provision for a whole spectrum of educational methods, tools, materials and resources for the learners to access on their own, in order to acquire the necessary knowledge and/or skills through auto-education. Note that, although learners are acquiring knowledge and/or skills, this acquisition is meaningful because they have realised that they are lacking it and that they need it to solve the problem. They also learn how and where to acquire knowledge and skills when they need it. Lastly, they have become more independent, because they had to acquire the knowledge and skills through their own efforts.

(v) Edutainment

One of the most important criteria for life in general, and obviously for learning is efficiency. Efficiency is determined by the combination of time it is taking to complete a task, the effort that was exerted in completing the task and the accuracy with which it has been completed. If for any reason time and or accuracy and/or effort becomes paramount for efficient learning, then, and only then, may facilitating learning require a special kind of intervention: , which may result in what has been called "teaching" in the old paradigm: Supplying information, demonstrating or illustrating something, showing something to be imitated, telling something to memorise, explaining something to be "understood", engaging in a Q and A discussion or the demand to become proficient in

a particular skill through drill and practice. This will happen **only under very special conditions**. These conditions appear when learners are busy with LTE and the problem they need to solve demands at a particular time that a particular piece of information or a particular skill is a necessary precondition for being able to continue with solving the problem. The facilitator also knows that, acquiring this particular piece of information or skill through the authentic learning process, will take up so much time and/or may require so much effort to produce the accuracy required, that the learners will be distracted from achieving the actual learning outcome that will compel them to fully utilise their potential in the most efficient way. It means that acquiring this intermediate piece of information or skill, is not an aim in itself, but serves only as a means to achieve the intended outcome in the most efficient way. Only under these very special conditions may the FOL employ the particular activities that will justify learning methods and strategies aimed at regurgitating and repeating like watching, listening, imitating, memorising, drill, practice, etc. But under these conditions, these facilitating learning activities are called edutainment.

Edutainment is a very important part of facilitating learning. Edutainment is prompted by the real disposition of the learners. It is created by a need from the learners - the learners govern - or knowing full well that the learners will need the information/data or skill at a particular point in time for a "higher" purpose. There are very important prerequisites for implementing edutainment: The facilitator of learning will edutain only when there is no other possible way that learners will be able to obtain the information/data or acquire the skill they need right now within the reality of the time limit allocated or reserved to solve the problem. Whether edutainment will be implemented or not will be guided by the question whether edutainment will be the most efficient way for learners to obtain the necessary information/data and/or acquire the necessary skill? If learners are left to obtain the information or acquire the skill in any other way, will time, accuracy and effort unnecessarily be wasted in which much more important learning could have been done? Will this cause the learners to become distracted in solving the actual problem at hand efficiently? Is the learning process of obtaining the information or acquiring the skill a crucial learning experience or are they rather only a means to get to the solution of the current problem more efficiently for potential to be maximised? Whenever a decision has been made to implement edutainment, the format in which it is done is also crucial. As far as possible, it should be done in the dramatic style through the Socratic method and the purpose of the edutainment is always to:

Provoke; disturb; create disequilibria; cause uneasiness and discomfort; stir; shake; touch the emotions; bring into sharp focus; rock the boat; unsettle; deceive; mislead; impact; stun;be radical;have learners really reflect and think critically and creatively!

There is, however, a circumstance under which learning a skill as quickly as possible (through demonstration, imitation, etc) is justifiable. This is when job creation to solve an immediate economic need becomes inevitable. But, this short-term learning has to articulate with the potential of long-term development – it means that, although it is an aim in itself in the short term, it can be only a means to eventually fulfil the aim of education. Important to note again is that learning a skill in this way, focuses on the skill itself and not how it relates to conditions, circumstances, and the environment. And since circumstances, conditions, and the environment is in a continuous mode of dynamic change, it also continuously requires new skills, and it simply becomes futile for a learner not to be challenged through facilitating learning to maximise his/her potential.

3. Learning task consolidation (LTC)

Learning is maintained through LTC at the end of the learning period. A few minutes before the end of a particular learning period, the FOL has to request learners to consolidate what they have learned up to that point and to present it to the entire group of learners. It is of the utmost importance:

a. To ascertain the rate of the learning progress

The FOL demands from learners to share what they have learned up to that particular point in time with the entire group, and, learning from what how far their peers have progressed, the FOL and learners can ascertain the rate of learning progress.

b. To assess the quality of learning

Not only does a simple sharing of what learners have learned take place, but rather a critical assessment of what has been learned by the peers and the FOL. This determines the quality of the learners' learning.

c. To determine the next challenge

Having established the progress and the quality of learning up to that particular point in time provides the opportunity for learners to realise what they have achieved during that particular learning period and to envision what still need to be achieved to fulfil the required outcomes. For the FOL this is also available, and, in addition it allows the FOL to determine what the challenge for the next learning period should be and how it should be executed.

EDUCATING STUDENTS TO BECOME EXCELLENT FACILITATORS OF LEARNING

There could be little doubt that the future increasingly demands learners who are able to take responsibility for their own learning and are therefore able to plan, execute, monitor and assess their own learning to become active, effective, independent, lifelong learners through fully utilising their potential to acquire the fundamental life skills. It should also be clear that this could only be achieved through facilitating learning as has been described in the previous paragraphs. However, at the moment we are currently dealing with a particular education practice of which the requirements are still much rooted in another paradigm. For this reason, the PGCE programme will take as its point of departure four education paradigms of which the quality of learning has been identified to progressively increase from one paradigm to the other. The PGCE programme will therefore be structured in such a way that students progress from one paradigm to the next until they have fully utilised their potential to facilitate learning in the transcendental paradigm in an extraordinary way. The details of this progression will be indicated in a next section. The essential characteristics of each of the education paradigms as they have been initiated by, amongst others, Dewey (1944), Piaget (1952;1958) and Vygotsky (1978) and substantiated by Joyce, Weil and Showers (1992), Miller (1996), Arons (1997), Freiburg and Driscoll (2000) Miller (2003) and Engelström (2004) has been summarised as follows. It should be obvious that the summary indicates distinctive characteristics and therefore portrays what would be dominant in its implementation in practice.

FOUR EDUCATION PARADIGMS / *VIER ONDERWYSPARADIGMAS*

ONDERWYSPARADIGMA **EDUCATION PARADIGM** / **EDUCATION COMPONENT** / ***ONDERWYSKOMPONENT***	**Transmission** ***Transmissie***	**Transaction** **Transaksie**	**Transformation** **Transformasie**	**Transcendental** **Transendensie**
Aim **Doel**	To impart knowledge *Om kennis oor te dra*	To understand *Om te verstaan*	To apply knowledge *Om kennis toe te pas*	To generate knowledge *Om kennis te genereer*
Education mode **Onderwysmodus**	Direct teaching *Direkte onderrig*	Interactive teaching *Interaktiewe onderrig*	Project education *Projekonderwys*	Facilitating learning *Fasilitering van leer*
Focus **Fokus**	Factual knowledge *Feitelike kennis*	Factual understanding *Verstaan van feite*	Application *Toepassing*	Creative construction of meaning (knowledge) *Kreatiewe konstruksie van betekenis (kennis)*
Educator action **Onderwyseraksie**	Tell, illustrate, demonstrate, explain *Vertel, illustreer, demonstreer, verduidelik*	Questioning, discussing *Vraagstelling, bespreking*	Give assignments, projects, guidance, help *Gee opdragte, projekte, leiding, hulp*	Confront the learners with a real life challenge they have to resolve themselves *Konfronteer leerders met 'n lewenswerklike uitdaging wat hulle self moet oplos*
Learner action required **Leerderaksie verwag**	Absorb, memorise, drill, practice *Absorbeer, memoriseer, dril, inoefen*	Answering questions, discussing *Beantwoord vrae, bespreek*	Exploration, discover, experimentation, *Eksploreer, ontdek, eksperimenteer*,	Creatively constructing new knowledge *Kreatiewe konstruksie van nuwe kennis*
Learning mode **Leermodus**	Receptive *Reseptief*	Interactive *Interaktief*	Self-active *Selfaktief*	Self-directive *Selfgerig*
Learner autonomy **Leerder outonomie**	None *Geen*	Some *Min*	Much *Heelwat*	Total *Totaal*
Level of learning **Vlak van leer**	Shallow *Vlak*	Insight *Insig*	Deep *Diep*	Transcendental *Transenderend*
Learning outcome **Leeruitkoms**	Cognitive Kognitief	Social *Sosiaal*	Multiple *Veelvuldig*	Holistic *Holisties*
Outcome **Uitkoms**	Core concept reproduction *Kernkonsepreproduksie*	Core concept understanding *Kernkonsepbegrip*	Enriched curriculum *Verrykte kurrikulum*	Living real life *Leef die werklikheid*
Learning quality **Leerkwaliteit**	Low *Laag*	Medium *Medium*	High *Hoog*	Maximum *Maksimum*

The transmission, transaction and transformation education paradigms are regarded to be traditional education paradigms in which lessons are planned and presented. It is only the transcendention paradigm which require authentic learning in the holistic sense of the word and the corresponding LTD and LTO as it is demanded in facilitating learning. This does not mean that some actions described as facilitating learning actions are not or cannot be used during the implementation of the other education paradigms. In fact, it should be encouraged that as many as possible of the facilitating learning actions be used in lesson plans and presentations so that composite competence in facilitating learning is enhanced as students move towards the transcendental paradigm.

THE FOUNDATION OF EDUCATING FACILITATORS OF LEARNING IN THE PGCE PROGRAMME.

To become facilitators of learning students need to be educated to execute all the actions of facilitating learning described in the previous paragraphs, and fully utilise their potential to become excellent facilitators of learning. However, the way in which students are educated to do this has to be as unique as the education paradigm of facilitating learning is. The fundamental goal of the PGCE programme is to educate each student to become a professional Facilitator of Learning (FOL). This requires student FOL's to engage in a continuous professional development programme through which they construct their own practice theory of and for Facilitating Learning (FL) on which their entire professional education practice is based.

a. Professional practice and practice theory

The traditional goal of teacher education is "to teach expert knowledge (resulting from psychological, sociological, and educational research) to student teachers, who can then use this expertise in their practice …. This view leads teacher educators to make a priori choices about the theory that should be transmitted to student teachers. Research shows that this approach has very little effect on practice" (Korthagen, 2001:255) and does not resolve the age old rival dichotomy between "theory" and "practice". In fact, this scientific understanding of education (episteme – see table 4) does not produce the fundamental change in education that is necessary for an ever increasing uncertain future that is emerging. What is necessary, rather, is practical wisdom (phronesis – see table 4) (Korthagen, 2001: 24). Education is a professional practice and as such requires professional praxis knowledge rather than disciplinary based theory. Professional knowledge is derived from practice. Korthagen's (2001: 261) research has shown that it is when student teachers are exposed to and challenged with living through new experiences and continuously reflect on them, that they understand the principles that cause their practice to be successful. Only then are they able to consciously construct new conceptions and internalise fundamental change in their own learning and the way they educate learners. This construction represents the theory of their practice and is known as a practice theory. It is a principle-centred, context-dependent theory that forms the solid foundation, which guide their instantaneous decision making to solve the problems of their professional practice and improve subsequent practices. (Korthagen, 2001; Furlong, 2000) The entire PGCE programme revolves around student FOL's constructing their own practice theory from case studies (reported research on cases in practice) and practical experience, and then using that practice theory as a solid foundation from which they design and execute their own unique professional practices, reflect upon it and improve it.

Table 4 Types of knowledge (Korthagen, 2001:20-31)

Knowledge as episteme	**Knowledge as phronesis**
Expert, scientific knowledge (theory)	Individual practical knowledge
Needs scientific understanding	Needs practical wisdom
Knowledge of universal principals	Knowledge of concrete particulars
Locus of certitude: Principles	Locus of certitude: Particulars
Knowledge is conceptual	Knowledge is perceptual
Knowledge is rigid	Knowledge is flexible
The principle (concept) dictates the practice	Uses the practice to discover a guiding rule/principle/procedure/method
Knowledge learned (memorised) and "applied"	Knowledge acquired through enough, appropriate and proper ***experience*** (perceiving, assessing, judging, choosing

	actions, execute them, be confronted with its consequences and learn from them)
Provides principle	Provides holistic insight
Teach the student concepts - avoid will, emotions, etc they disturb	Help the student see - celebrate will, emotions, etc they provide insight

b. Practice Theory

What it is:

- The "practice" (Afr. praktyk) in practice theory refers to each individual student FOL's education practice (Afr onderwyspraktyk): What student's do when they are preparing to facilitate learning during learning task design (LTD) and when they are actually facilitating learning in practice during learning task operation (LTO).
- The "theory" in practice theory refers to the body of systematised knowledge about and for each individual student's practice as facilitator of learning.
- Each individual student's practice theory is therefore the theory of that individual's practice derived primarily from the student's personal practice experience. It is therefore a theory.
- It is continuously informed and enriched by each individual student's practice as such (through reflection by the student on his or her own practice and/or action research of her or his own practice) but also by other practices of other facilitators of learning as well as other already existing theories (research) in education.
- It is therefore in a continuous process of development.

What its function is:

- Each student's practice theory is the foundation from which he or she operates in practice.
- It tells the student what to do and how to operate in practice.
- It therefore determines all the student's actions in your practice.
- It provides all the reasons why the student is operating in practice the way the student does.
- It provides the rational for what the student is doing as facilitator of learning.
- When student's are asked questions about their practice they need to student able to explain everything in terms of their practice theory.

Practice theory in the format of a concept map (and explanatory notes)

A concept map is a creative (colourful, playful, animated) construction of the relationships between a set of (selected) concepts indicating the nature, distance, and relatedness of the relationships between the concepts. A self-constructed concept map is reveals a learner's understanding of what the concept map represents (as opposed to a mind map). It reflects the differentiation between the concepts, as well as the nature and structure of the contextual relationships between the concepts as it manifests in an integrated meaningful whole. It reveals the learner's ability to construct meaning through identification, exposition and definition of distinguishable meaningful units, and recognising, discovering and creating relationships.

Concept maps are considered to student a valuable tool for assessment because they provide an explicit and overt representation of the students' knowledge and promote meaningful learning (Mintzes, Wandersee & Novak, 2000; Novak & Gowin,1984; Novak, 1998). Pearsall, Skipper & Mintzes (1997) reports that concept maps provide a unique window into the way learners structure their knowledge, offering an opportunity to assess both the prepositional validity and structural complexity of their knowledge base. What is also crucial is that concept maps provide a means to capture, elicit and represent qualitative aspects of students' knowledge (Novak & Gowin 1984). Since concepts maps deal with concepts, there is no discipline in which they may not student used. They have been used widely for a variety of educational purposes and functions (Jonassen, reeves, Hong, Harvey & Peters, 1997; Novak 1990) as a curriculum organisstion guide, as an instructional tool, as a tool to promote meaningful learning and as an assessment tool (Mintzes, Wandersee & Novak, 2000; Trowbridge and Wandersee, 1998)

As a learning tool, concept maps can serve to help students to learn, to create and to use knowledge (Gouli, Gogolou and Gigoriadou, 2003: 216-217; Novak,1998: 45-67). In this sense it is consistent with

constructivist epistemology and cognitive psychology (Edmondson, 2000). The concept mapping process:

a. promotes and assists meaningful learning (Hill, 2004: 4; Fisher, Faletti, Patterson, Thornton, Lipson & Spring, 1990; Novak 1998; Novak 1990) by encouraging students to identify concept meanings, to establish their own relationship between concepts, to rearrange the existing relationships, to relate new concepts to prior concepts, to organise the concepts in a hierarchical and integrated manner and to refine the completed map;
b. helps students to organise knowledge in meaningful related chunks (Novak, 1998), promoting better knowledge organization in memory, better retention, retrieval and utilisation of knowledge in new situations;
c. Helps students to realise that learning requires their active and constructive involvement, to understand better the content and the process of effective, meaningful learning (Edmundson, 2000) and to learn how to learn by bringing to the surfice cognitive structures and self-constructed knowledge (Novak & Gowin, 1984)

Concept maps as assessment tool can also reveal to both students and teachers the quality and the level of the development of their conceptual understanding for any domain at any grade level (Novak, 1998). Novak & Gowin (1984) found that concept maps gave teachers and researchers more accurate and more authentic insights into students' thinking than traditional methods of testing (Walker & King, 2002). A concept map also provides a better gauge of what students know than most other assessment tools because it allows free response and it provides insights into the students' knowledge structure (Gouli, Gogolou & Gigoriadou, 2003). Not only are concept maps reliable and valid, but they also measure aptitudes not commonly assessed by typical objective tests. These positive effects have been shown also by lots of research studies in different age and culturally diverse students (Horton, McConny, Gallo, Woods, Senn & Hamlin, 1993; Novak, 1990, 1998).

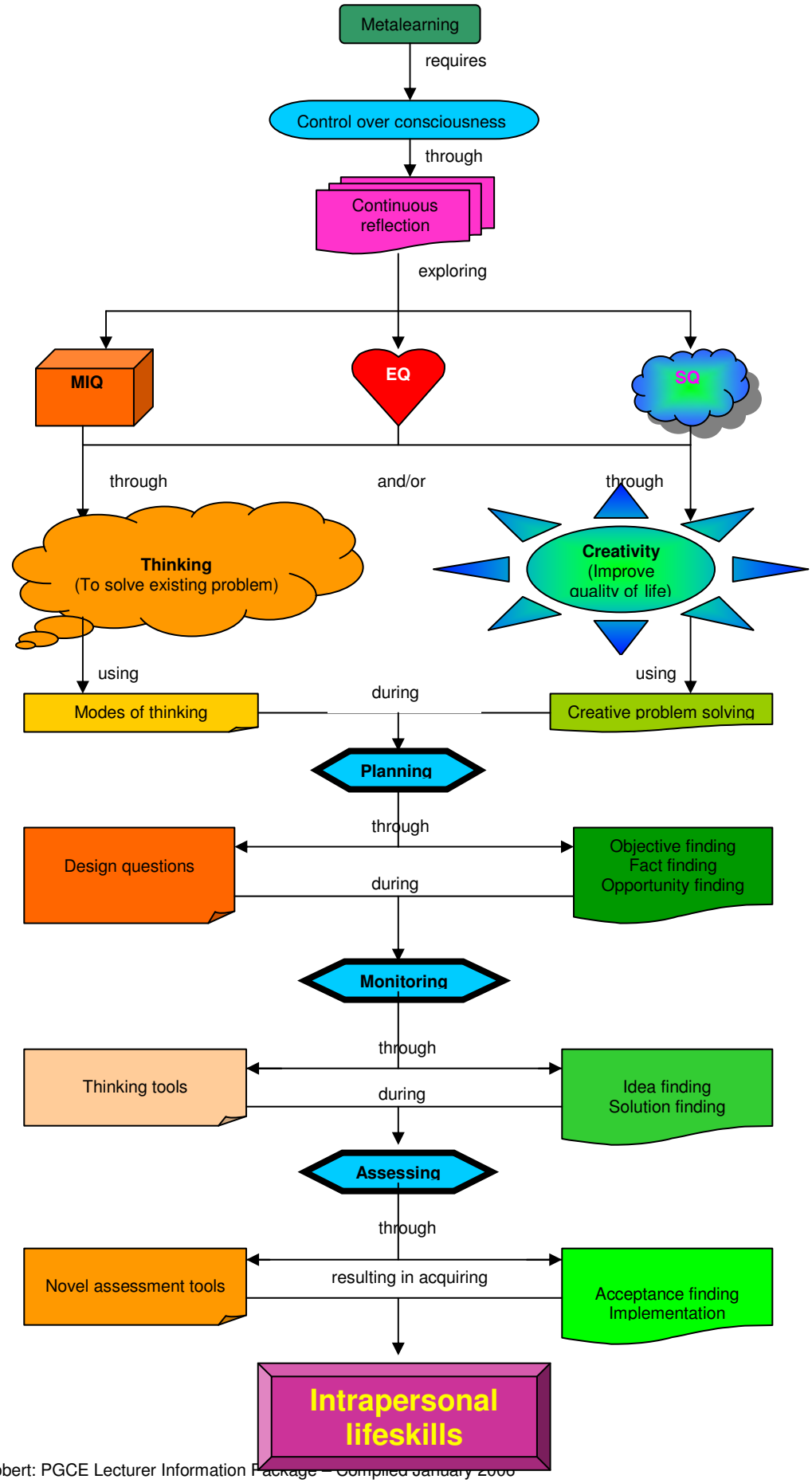
The preceding paragraph is self-explanatory regarding the reason for the preference that the practice theory should student constructed in the form of a concept map (with explanatory notes - where it studentcomes inevitably necessary).

To qualify as a concept map, the following criteria should student observed:

- A concept map consists of concepts – meaningful units which, in itself, has meaning.
- A concept map consists of at least two concepts.
- Each concept in a concept map has to student linked to at least one other concept by a line that indicates a relationship between the two concepts. Any one concept, however, may have a relationship with many other concepts.
- An arrowhead has to indicate the relatedness between the concepts. There may student a reciprocal relationship between two concepts that should student indicated by an arrowhead directed to each of the two concepts.
- The nature of the relationship between two concepts should student indicated with a written linking word on the linking line.
- The distance of the relationship should student indicated by the length of the linking line.

On the next page, a concept map of metalearning is depicted. Please note that some software programmes may have unfortunate detrimental limiting consequences for the ultimate construction of a concept map as in this particular case regarding some criteria. Whatever the medium, concept maps should comply to all essential criteria.

CONCEPT MAP OF METALEARNING



c. The curriculum

To become competent professional practitioners, the students will engage in a professional and specialisation curriculum.

d. The professional curriculum

As the name indicates, the professional curriculum aims at equipping the Students with professional competence in education. The following modules form part of the specialisation curriculum:

FCL 420	Facilitating Learning
LNT 410	Learning Theories
ASS 410	Assessment
GPE 410	Global Perspectives in Education Learners with special education needs
FOE 410	Foundations of Education
COE 410	Social Context of Education (d) Diversity (a) HIV/Aids
PEL 410	Professional Ethics and Law
PPF 420	Professional Portfolio
ICT 410	Information and Communication Technology

The absolute foundation of the professional curriculum is the module of facilitating learning (FCL). FCL is the basis of the professional curriculum. Being a professional means, in the most practical sense, the following:

a) Professionals exercise a professional ***practice***.
b) They design unique professional practices from a self constructed ***principle centred practice theory***.
c) The practice theory has been derived from ***practical experience***.
d) Professionals are competent in many skills (strategies, methods and techniques) – but this is exactly what an artisan (a skilled worker) is competent in.
e) Professionals, however, are competent on a much higher level: They are able to ***make the best possible founded choices*** from existing skills to design a unique practice.
f) More importantly, they are able to ***creatively design new skills*** to achieve the best possible outcome.
g) Professionals are able to ***monitor*** what they do every step of the way, to ensure the best possible outcome at all times.
h) This means that professionals are able to make the most appropriate, responsible and accountable ***instantaneous decisions at any required moment*** to pursue the best possible outcome despite what has been designed.
i) Professionals are able to ***critically assess*** all their actions and its consequences against a solid foundation in a reflective mode to:
   - precisely pinpoint the very instances of his/her success, failure or uncertainty;
   - accurately diagnose its cause;
   - correctly identify - but even much more importantly - creatively generate alternative possibilities;
   - confidently make the best possible choice for follow up action;
   - and boldly engage in the improvement of the original attempt.
j) Professionals are ***independent*** and do not ***rely*** on anyone else to do the job.
k) ***No one else*** but a professional can do the professional's job.

5. The aim of the professional curriculum

The professional curriculum provides the professional foundation for facilitating learning. The module, Facilitating Learning, is therefore foundation of the professional curriculum. All the other professional curriculum modules (excluding ICT and PPF) are service modules for FCL and as such all other modules should eventually be effectively integrated into FCL. The aim of the professional curriculum is to construct a practice theory of and for facilitating learning, which the students implement to ensure

the highest possible quality of facilitating learning practice. All other professional curriculum modules (except ICT and PPF) therefore have this as its aim. The assumption therefore is that all other professional curriculum modules (except ICT and PPF) will have the students construct a (practice) framework of any appropriate kind of the particular module ONLY in so far as it DIRECTLY impacts facilitating learning practice. That is why the professional curriculum modules should not be entertained as stand-alone modules (disciplines), but the students need to experience their delivery directly contributing to the quality of their facilitating learning practice. . The construction of such a framework and its continuous assessment as suggested above for each professional curriculum module (except ICT and PPF) is more than sufficient to gauge students' understanding of the essential principles, foundational concepts and their interconnectedness, and to contribute effectively to their facilitating learning practice. Lecturers of the professional curriculum modules are requested not to give additional assignments to students – especially assignments to be completed during students' school based education periods unless such assignments theory-practice integration of your module and holistically and directly integrated with students' facilitating learning practice. All assignments should be completed and submitted during the last scheduled contact session.

5. Suggested delivery of the professional curriculum (except FCL, ICT and PPF)

The delivery principal is that all contact sessions with students should be learningshop sessions: A learningshop is when students present their attempt at the construction of the required framework (or aspect thereof). They then actively participate in the learning process sharing their own contributions and critically assess their own and the others' contributions as it is being shared solely to improve the learning quality and subsequently the quality of the end product outcome of each individual's learning regarding the framework. With each contact session an increase in the quality of the construction of the framework is expected which should be influenced especially by what they have learned through their facilitating learning practice during their school based education periods. What follows is a recommendation on how this principle could be implemented:

a. From the field that constitute your module, identify only those prominent areas that correlate most appropriately with the foundation and philosophy of the PGCE programme.
b. Carefully select learning material that would appropriately represent these identified areas to not exceed 140 pages – the student may (and should be encouraged to) consult additional relevant material within limits.
c. The students are divided by the programme manager into cooperative learning (CL) groups of four in each group. Divide the learning material into as many equal bits as there would be CL groups. During your first contact session with the students, provide all students with all the learning material, but indicate to each CL group, which is their bit of learning material which they need to prepare for presentation to the entire PGCE student group.
d. Negotiate a schedule during which time each CL group will do their presentation. All students study the learning material that would be presented at a particular time because they need to ask the presenters clarifying and probing questions during and/or after the presentation.
e. The presentation is in the form of a concept map or any other appropriate structure that would allow for only the absolute essence of the material to be presented in a meaningfully, holistically integrated format. The CL group supplies a copy of their presentation to all the students.
f. The presentation is self –assessed, peer assessed, and assessed by the lecturer and the mark thus accumulated by the CL group is allocated to each member. In addition, each individual member of the CL group assesses each other member's contribution confidentially and the mark each individual received is accumulated with that which the group attained which gives an aggregated individual mark.
g. As each CL group presents their material a cumulative concept map (or any other appropriate structure) is constructed collaboratively by the entire group, facilitated by the lecturer, and it is elaborated and improved each contact session time, until, at the end, everyone posses a high quality concept map (or any other appropriate structure) of the module.
h. The mark accumulated for each student regarding these presentations could serve as the first semester mark – you are reminded that you have to allocate a first semester and a second semester mark for each student of which the average is the final mark.
i. What could fit well into the PGCE programme as theory-practice integration of your module and holistically and directly integrated with their facilitating learning practice the following example from the Learning Theories module is supplied: Students need to video record some of their LTO's as part of the module Facilitating Learning. For the Learning Theories module (or any other

professional curriculum module for that matter) the students may use one (or more) of these video recordings to identify the learning theories that are in operation, justify its use and assess the quality of its implementation to subsequently improve their facilitating learning practice. This assignment should be assessed and a mark allocated.

j. The mark for the assignment indicated in i. above, could serve as a second semester mark.

RESPONSIBILITIES OF PROFESSIONAL CURRICULUM LECTURERS:

Lecturers appointed/allocated to the professional curriculum are responsible for the following:

(i) Design of the curriculum for the module which includes the compilation and/or upgrading of a study guide.
(ii) Development, assessment, evaluation, and quality assurance of the curriculum on an on-going basis.
(iii) Delivery of the module as suggested above according to the scheduled timetable .
(iv) Accumulating a first semester mark for each student as a progress mark and providing it ***directly to the administrative officer*** at the academic administration of the Faculty of Education responsible for the PGCE in the required format on the marking list and on the required date (information obtainable from Me Melinda Joubert: 420-5590; mjoubert@hakuna.up.ac.za) ***and you keep a hard and electronic copy*** for your own safekeeping.
(v) Accumulating a second semester mark for each student, which, together with the first semester mark - in whichever formula of aggregation you deem most appropriate - serves at the same time as the final year mark, the examination mark, and the final achievement mark. You also provide these marks ***directly to the administrative officer*** at the academic administration of the Faculty of Education responsible for the PGCE in the required format on the marking list and on the required date (information obtainable from Me Melinda Joubert: 420-5590; mjoubert@hakuna.up.ac.za) ***and you keep a hard and electronic copy*** for your own safekeeping.
(vi) Availability during the final assessment period to assess at least 10 student's professional development portfolio defences and interviews.

6. The relationship between the Professional and Specialisation Curriculum

The entire Professional Curriculum and in particular the comprehensive, integrated, holistic practice theory of facilitating learning in the form of a concept map informs (is the foundation of and supports) the specialisation curriculum in which the actual professional practice is manifest. But how the particular field of specialisation is practiced, depends on the nature and structure of that particular specialisation. The specialisation curriculum therefore focuses on the identification of the nature and structure of the field of specialisation and the identification and selection of the relevant support mechanisms from the constructed generic practice theory of facilitating learning to the specialisation practice theory – ***however, it is not necessary to construct a practice theory of facilitating learning in the form of a concept map for a specialisation***, because the ***LTD and LTO*** for the particular specialisation, will actually ***represent its practice theory***. **BUT**, what is of pivotal importance is that **EVEY SINGLE LT** has to be designed and operationised **ACCORDING TO THE BE's PRACTICE THEORY OF FACILITATING LEARNING IN THE FORM OF A CONCEPT MAP THAT WAS CONSTRUCTED IN FCL – This is the only practice theory that we are referring to.** This manifests the relationship between the Professional and Specialisation curriculum. In the most literal sense, you as specialisation lecturer has to demand that the students design LT's with their practice theories next to them and they have to justify every design element by referring to their practice theory. When students operationise their LT's, assessment has to be based on how the student justifies his/her actions according to his/her practice theory – again, the practice theory serves as the pivot for the assessment discussion. This characteristic will be at the centre of the specialisation curriculum assessment, meaning that the LTD and LTO has to be assessed against the students constructed practice theory. This, therefore forms the basis from which the Students will conduct their practice. The major focus of assessment in the specialisation is the assessment of their actual education practice during their school based education (SBE) at the schools regarding the students learning task design (LTD) and learning task operation (LTO) when students have the learners execute the designed learning tasks (LT's). Additional particulars about assessment in the Specialisation follows a little later.

8. Suggested delivery of the specialisation curriculum

Following is a summary of how the programme is designed to operate ***for each of the 2 specialisations*** where applicable **OR** ***per semester*** where only one specialisation is offered. Since Specialisation lecturers have only a compulsory 1 hour contact session during each indicated time slot for the Specialisation, this time should be utilised wisely in learningshop format to compel students to be meaningfully occupied for the remaining time scheduled on the timetable when the Specialisation lecturer may not be present.

Contact session number	Length (hours)	Purpose
1	1	Orientation to the Specialisation
2	1	Establishing the nature and structure of the Specialisation and how this determines its facilitation of learning.
3-4	2	• Analysing the programme students received at the school which they need to take responsibility for during the SBE to determine the range of the outcomes to be achieved. • Making a provisional time allocation: Fitting the required outcomes to a time schedule within the available allotted time of the SBE.
5-7	3	Obtaining all available materials from which learning tasks can be designed for the achievement of all the required outcomes. This allows determining the scope, possibilities, limitations and implications of the particular required outcomes to be achieved.
8-14	7	***Learning Task Design (LTD)*** by students LT's with the facilitating aid of the Specialisation lecturer. The designing of the required LT's according to the SBE programme is used as the meaningful point of departure to explore the broader and deeper substantive (content/product) and syntactical (methodology/process: skills, strategies, techniques) structure of the Specialisation as it determines its education in a just in time (JIT) learning principle.
15-16	2	Constructing a plan of action for the improvement of each BE during the remainder of the SBE.
34 DAYS OF SBE		***Learning Task Operation (LTO)***: The SBE session is allocated to the Specialisation with the focus on LTO where BE's present learners with a designed LT which they – the learners – have to execute. This is also the time during which the ***Specialisation lecturer will assess each BE at least 2 times.***

Designing and operationing LT's according to the required demanding criteria constitutes the essence of what FOL's do. These are the essential and meaningful activities students should be involved in during their education as FOL's.

Assessment of the students regarding the Specialisation consists only of their work in practice at the schools during SBE: ***Per semester per student***, it consists of at least 2 formal assessments of the Specialisation lecturer, at least 4 formal assessments of the Mentor Educator on different occasions, at least 2 formal peer assessments also different from the Specialisation lecturer and the Mentor Educator, and at least 4 formal self-assessments on different occasions than all the others – a total of 12 formal assessments. You as Specialisation lecturer are responsible to collect all the grading from the respective assessment agents and compile from them a final grading for the specialisation – you determine the weighting of each assessment category of which your assessments have to carry at least a 50% of the total weighting.

Only when and if ALL the categories of competences (learning outcomes) regarding the particular learning area/programme/subject ***are not covered*** within the programme the students need to follow at their schools, it is suggested that they do design LT's to incorporate those, but they operationise them with their peers and it should be assessed as if it was part of their practice at a school. This adds one other additional category of assessment which should be incorporated in the students' final grading with a weighting according to your discretion.

Students need to progress effectively through all the education paradigms by becoming competent in each one before moving on to the next. Progressing through the paradigms is suggested in the following way:

- During the first semester students are not required to operationise LT's in the transcendental paradigm. They are, however, required to plan and present lessons in the transmission and transaction paradigms and experiment at least once with transformation paradigm. However, during the first semester, students need to at least design one LT in the transcendental paradigm. This LTD should be assessed and the mark allocated for it should at least weigh 25% of the semester mark. Mark accumulation for the first semester: 50%-Specialisation lecturer assessments; 25%-Mentor assessment of the LTD in the transcendental paradigm; 25%-Mentor assessments+peer assessments+self-assessments.
- During the second semester the students should design and operationise at least 4 LT's in the transcendental paradigm of which two have to be assessed by the Specialisation lecturer and the two others by the Mentor educator. The mark accumulation for the second semester should be: 50% Specialisation lecturer assessments; 25%-Mentor assessments of the 2 LT's in the transcendental paradigm; 25%-All other Mentor assessments+peer assessments+self assessments.

RESPONSIBILITIES OF SPECIALISATION CURRICULUM LECTURERS:

Lecturers appointed/allocated to the specialisation curriculum are responsible for the following:

(i) Design of the curriculum for the module, which includes the compilation and/or upgrading of a study guide.
(ii) Development, assessment, evaluation, and quality assurance of the curriculum on an on-going basis.
(iii) Delivery of the module as suggested above with at least one face-to-face contact hour with the students per scheduled timetable session.
(iv) Ensure the effective progression of students through all the education paradigms by approving all lesson plans and the education paradigm it has been designed in according to the progression through the paradigms indicated above.
(v) At least two lesson/LT assessments during school practice at the school per student per semester.
(vi) Accumulating a semester mark for each student each semester (where appropriate) and providing it ***directly to the administrative officer*** at the academic administration of the Faculty of Education responsible for the PGCE in the required format on the marking list and on the required date (information obtainable from Me Melinda Joubert: 420-5590; mjoubert@hakuna.up.ac.za) ***and you keep a hard and electronic copy*** for your own safekeeping.
(vii) Accumulating a final mark from the two semester marks for each student and providing it ***directly to the administrative officer*** at the academic administration of the Faculty of Education responsible for the PGCE in the required format on the marking list and on the required date (information obtainable from Me Melinda Joubert: 420-5590; mjoubert@hakuna.up.ac.za) ***and you keep a hard and electronic copy*** for your own safekeeping.
(viii) Assessment of each student's professional development portfolio.

9. Development of a Professional Development Portfolio

The students will compile a professional development portfolio. It will incorporate the development of their practice theory for facilitating learning and a very carefully verified selection of all their work supported by substantial and meaningful reflections which should portray their professional development as facilitator of learning. The format of the portfolio should make provision for the incorporation of all required and appropriate items that could also include original physical objects, but it should also portray students' professional competence in implementing multimedia, multifaceted, multiformatted, dynamic systems. Since it is now hopefully much clearer what the intention is with each module and how the entire curriculum relates in context, the suggested format for the Study Manual for each module and what should be incorporated in its content, will be helpful.

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D. STUDY MANUAL

A cover with the following information:

UNIVERSITY OF PRETORIA
Faculty of Education

Professional Curriculum
or
Specialisation Curriculum

Study Manual for Module Name and Code

Responsible PE's name

Date of compilation

The inside with the following information

Disclaimer

Please take note that any part or the entire Study Manual may change at any time due to the rapid change and development of education in South Africa and worldwide and the fact that this entire programme is at this stage subject to research and in that regard a developing programme. However, you will be informed of the changes in good time so as not to have any negative influence on your own professional development as facilitators of learning.

A. Organisational Component

1. Professional Educator Information

- Name
- Building
- Office number
- Office tel no
- Email address

2. Sources

Under this heading you need to include all the learning materials the BE's (Beginner Educators) will need to study. Give complete and correct bibliographical details of the 3-4 substantial practice theory articles published or to be published in refereed and/or accredited journals. This would be the prescribed sources. You may add some sources to study for enrichment, but you need to keep this to a minimum because the total prescribed sources for the proper professional curriculum alone already amounts to 32 articles. Also remember, the BE's may only work on your module for the corresponding notional hours.

3. Assessment

Describe under this heading the following:

- What will be assessed?
- Details of how will it be assessed (the format of assessment practice).
- How each aspect will be graded.
- How the final grade will be accumulated.

4. Timetable

See Timetable for BE's

5. Structure of the module

Construct a diagramme (mind map or concept map) of the outline of the module with each study unit.

B. Study Component

1. Purpose of this Module

State the purpose

2. Study Unit Number

We suggest a study unit for every contact session or series of contact sessions. Supply a descriptive title for the study unit

3. Learning outcomes

Formulate the learning outcomes for this study unit in terms of end product outcomes.

4. Sources

Indicate the exact sources from the inventory in the organisational component to be used to achieve the learning outcomes of this study unit.

5. Workshop

Describe the nature of the workshop in the following way:

- How will you facilitate the ***initiation*** of the BE's learning, or what is the problem that you will pose for BE's to solve?
- What will be expected of BE's to do (the ***learning*** process) to solve the problem themselves?
- How will you facilitate the ***maintenance*** of the BE's learning, or what will you do to ensure that the BE's achieve the highest possible learning quality?
- How will you facilitate the ***consolidation*** of the BE's learning, or what will you do ensure that the BE's obtain the best possible learning outcome as a reinforced point of departure for their subsequent learning experiences?

6. Self-activity(s)

Formulate any number of activities that the BE's will need to execute on their own in writing that will not be assessed, but is a necessary prerequisite to enable them to execute the assignment(s). It should also represent a challenging and dynamic preparation for a contact session.

7. Assignment(s)

Formulate an assignment to be executed by the BE's that is a comprehensive integrated challenge. It may be something in addition to the self-activity(s) that should be executed for a contact sessions or it may be given as an assignment after a contact session.

8. Assessment criteria

Indicate the assessment criteria that will be employed to assess the assignment(s).

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UNIVERSITY OF PRETORIA
Faculty of Education

SPECIALISATION CURRICULUM

Study Manual
for
Mathematics
IPH 402
SPH 402
VWS 400

"The main concern of mathematics education is to provide pupils with opportunities to construct their own mathematical ideas." (Moodley, 1992)

"it would be difficult to lead a normal life in many parts of the world in the 20th century without making use of some kind of mathematics"

"mathematics provides a means of communication which is powerful, concise and unambiguous" (Cockcroft, 1982)

Hayley Barnes

Disclaimer

Please take note that any part or the entire Study Manual may change at any time due to the rapid change and development of education in South Africa and worldwide. The entire programme is at this stage subject to research and for that reason a developing programme. However, you will be informed of the changes in good time so as not to have any negative influence on your own professional development as facilitators of learning.

A. ORGANISATIONAL COMPONENT

1. PROFESSIONAL EDUCATOR INFORMATION

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BUILDING: Aldoel

OFFICE NR: E205

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E-MAIL ADDRESS: hbarnes@gk.up.ac.za

CONSULTING HOURS: By appointment

2. SOURCES

PRESCRIBED SOURCES
These can all be downloaded and printed from the websites indicated below:

(i) Paul Ernst “The impact of beliefs on the teaching of Mathematics”. Can be retrieved from http://www.people.ex.ac.uk/PErnest/impact.htm

(ii) Martin van Reeuwijk “ The role of realistic situations in developing tools for solving systems of equations”. Can be retrieved from http://www.fi.uu.nl/publicaties/literatuur/4763.pdf

(iii) Linchevski et al. “Indispensable Mathematical Knowledge (IMK) and Differential Mathematical Knowledge (DMK) – Two sides of the Equity coin”. Can be retrieved from: http://academic.sun.ac.za/mathed/Malati/Files/PME20001.pdf

(iv) Richard Skemp “Relational understanding and Instrumental understanding”. Can be retrieved from: http://www.tallfamily.co.uk/david/skemp/pdfs/instrumental-relational.pdf

(v) Alwyn Olivier "Handling pupils' misconceptions". Can be retrieved from:
http://academic.sun.ac.za/mathed/Malati/Files/Misconceptions.pdf

(vi) Vicky Inman "Questioning their mathematics". Can be retrieved from:
http://0-web.ebscohost.com.innopac.up.ac.za/ehost/pdf?vid=1&hid=107&sid=0fc19c85-8296-467b-ae28-4af891748a79%40sessionmgr107

RECOMMENDED SOURCES

(a) The Revised National Curriculum Document for Grades R – 9 for Senior Phase and Grades 10 – 12 for FET students.
(Available in the reserved section of the Groenkloof AIS or on the internet at the following site: http://education.pwv.gov.za)
You may also be able to purchase a copy directly from the Department of Education at the following address:
Sol Plaatjie House
123 Schoeman Street
Pretoria
Tel: 012 312 5911

(b) Paul Andrews "Mathematics is like football". Can be retrieved at:
http://0-web.ebscohost.com.innopac.up.ac.za/ehost/pdf?vid=2&hid=103&sid=b2dfbe0b-3fa3-47b5-a695-dadc46ab830e%40sessionmgr108

It is also recommended that you consult school textbooks on mathematics that are relevant to the phase you intend teaching. Try to use textbooks that were published after 1999. A variety of textbooks and teacher guides is available in the AIS for loan or you can purchase some at Juta Books in Hatfield Centre of Protea Books in Burnett street.

3. ASSESSMENT

In this specialisation, you will mainly be assessed on your professional development as a mathematics educator. This relates to issues such as your content knowledge, your lesson planning, facilitating of learning of mathematics, and using relevant literature to substantiate and defend your approach to the teaching and learning of mathematics.

The sources listed above are will assist you in grasping and comprehending the WHY, WHAT and HOW of the basis of your intended profession as a mathematics educator. It is highly recommended to read the recommended sources in order to accelerate and enhance your own frame of reference and thinking, and be in a position to critically engage in the construction of your own accountable practice theory.

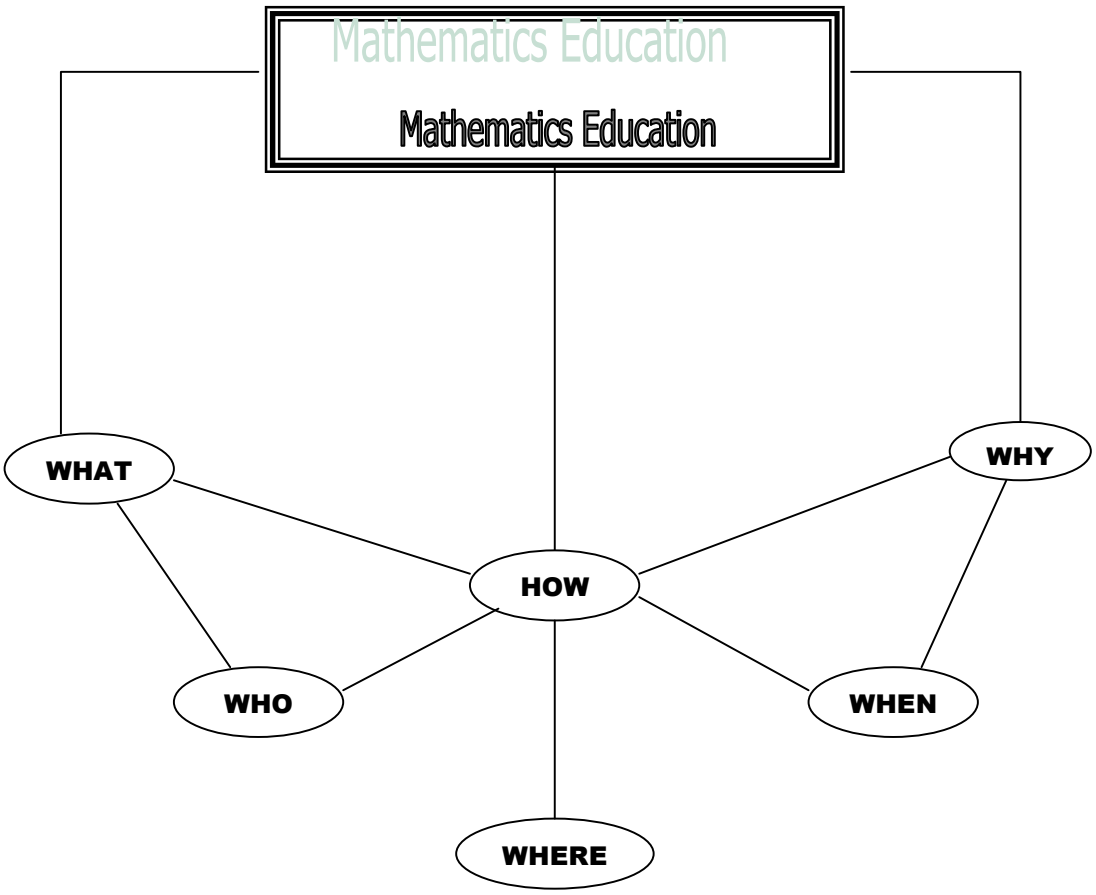
- **What** will be assessed?
  - Your professional practice as a mathematics educator in the context of the classroom.
  - Your mathematical subject knowledge and pedagogical content knowledge in the relevant phase of your professional practice.
  - Your knowledge of the unique nature, structure and methodology of this specialisation area.
  - Your critical account for the selection and use of support and assessment mechanisms within the domain of mathematics to facilitate teaching and learning.

- **How** will it be assessed? (format)
  - Professional growth is the ultimate aim of all the assessment.
  - Formal assessment for promotion purposes will mostly (60%) take place during the school-based teaching session at the schools, although there will be some assessments (40%) that will be conducted outside of the school context.
  - The following weighting system will be applied in compiling your final mark for this module:

	Peer & self assessment	**PE**
School practice assessment	10%	50%
Other assessment	10%	30%

- A rubric stating the marking criteria will be made available to you for all assessments.
- The final mark for this module will be calculated from the marks you receive for practice teaching from your mentors' as well as assessments conducted by myself.
- Additional informal assessment will also take place during contact sessions. The format will centre around actively participating in workshops, discussions and practical sessions.
- Although you will not always be given a formal mark for each of these sessions, you will receive feedback (from myself and your peers) as to your present level of proficiency and competency as described in the learning outcomes.
- If necessary, as determined through a process of self-reflection, peer assessment and other assessment, I may request to meet with you in order to improve the identified area(s) which require further improvement, growth and development.

4. STRUCTURE OF MODULE



5. TIMETABLE 2007

FET students to attend both SPE 1 and SPE 2 sessions

Session	SPE 1	SPE 2	Time	Hrs
1	Tuesday 26 Feb	Thursday 28 Feb	13:30 – 15:30	2
2	Tuesday 4 March	Thursday 6 March	13:30 – 17:30	4
3	Monday 10 March	Tuesday 17 June	14:30 – 17:30	3
4	Tuesday 11 March	Wednesday 18 June	14:30 – 17:30	3
5	Wednesday 12 March	Thursday 19 June	14:30 – 17:30	3
6	Thursday 13 March	Friday 20 June	13:30 – 17:30	4
7	Friday 14 March	Monday 23 June	13:30 – 17:30	4
8	Monday 17 March	Friday 27 June	13:30 – 17:30	4
9	Tuesday 18 March	Monday 14 July	13:30 – 17:30	4
10	Monday 31 March	Wednesday 16 July	13:30 – 17:30	4
11	Tuesday 1 April	Thursday 17 July	13:30 – 17:30	4
12	Friday 4 April	Friday 18 July	13:30 – 17:30	4
13	Monday 7 April	Monday 21 July	13:30 – 17:30	4
14	Wednesday 9 April	Tuesday 22 July	13:30 – 17:30	4
15	Monday 5 May	Monday 4 August	14:30 – 17:30	3
16	Monday 19 May	Monday 18 August	14:30 – 17:30	3

B. *STUDY COMPONENT*

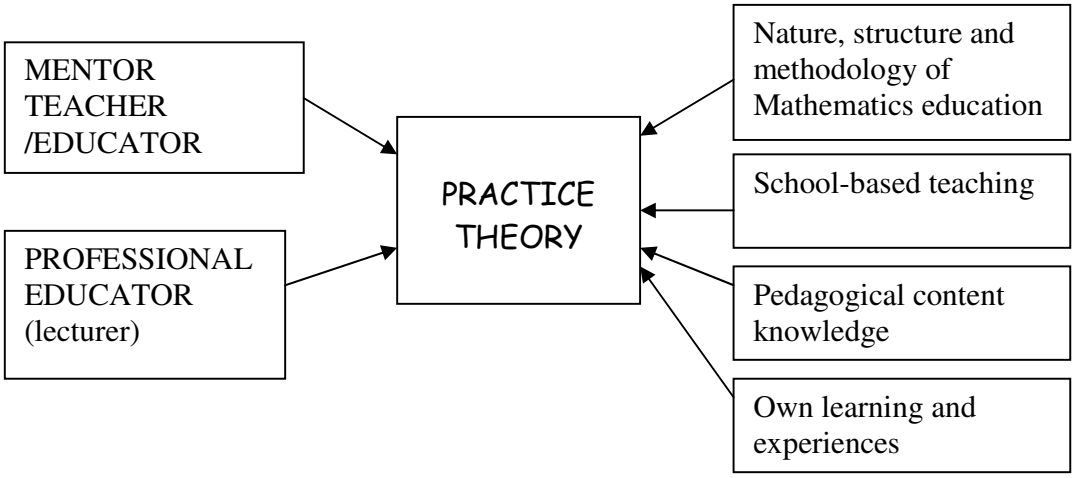
1. THE PURPOSE OF THIS MODULE

The purpose of this module is, according to the seven roles for educators, to demonstrate competence in selecting, using and adapting teaching and learning strategies in ways that meet the needs of all learners and the context concerned. This is specific to the learning area of Mathematics.

The course also seeks to afford you the opportunity to improve your content knowledge, conceptual understanding and pedagogical content knowledge required to be a competent mathematics educator in your relevant phase. It is important that you realise that times have changed since you were a learner. You are therefore encouraged (and urged) to avoid the temptation of restricting yourself to attempting to teach mathematics as you were taught it.

Outcomes – based education has been implemented in South Africa during the last few years. This course does not seek to make you an "OBE convert". It does however aim to give you the opportunity to explore theories and approaches to the teaching and learning of mathematics other than the traditional approach of "chalk and talk" and rote learning that has been the norm in South Africa for so many years. The course will also equip you with alternative assessment strategies other than traditional tests and exams to allow you to incorporate assessment as a learning tool in the teaching of mathematics.

It s hoped that the course will not only make you more positive about the learning area of mathematics but that you will in turn want to make it as accessible and applicable for the learners you will one day teach. You are therefore required to keep an open mind to the design and implementation of the course. Use this experience to your advantage and take up the challenge of stepping outside your comfort zone and trying something new. You are encouraged to integrate existing literature with your own experience in the classroom and that of other mathematics educators in order to create your own dynamic practice theory that will continuously be challenged, reflected on and developed throughout your career as an educator.



2. OUTLINE OF TOPICS COVERED

The WHAT and WHY of Mathematics Education

What:

- What is mathematics education?
- What do I have to teach learners?
- What do I as a mathematics educator need to know in order to teach mathematics to learners?
- What do I want to assess in mathematics?
- What is my own conceptual understanding of the content I will be required to teach learners?

Why:

- Why do I want to teach mathematics?
- Why do learners need to learn mathematics?
- Why do we assess learners?

The HOW of Mathematics Education

How:

- How can I effectively facilitate the learning of mathematics?
- How can I prepare a learning task design for a mathematics lesson?
- How can I assess learners in mathematics?
- How can I use collaborative learning effectively in the mathematics classroom?
- How can I work with different ability groups in the mathematics class?

The WHO of Mathematics Education

Who:

- Who will I be teaching? (which phase will I be focussing on)
- Who am I within my role as a mathematics educator?

The WHEN of Mathematics Education

When:

- When should I assess learners?

The WHERE of Mathematics Education

Where:

- Where can I go to learn more about mathematics education once I am qualified?
- Where can I teach mathematics?

3. LEARNING OUTCOMES

- Generate your own practice theory on Mathematics as a learning area
- Design the best mathematical practice according to your general practice theory.
- Critically execute, monitor and assess your practice of mathematical education against the mentioned theory.
- Continually improve the quality of your subsequent mathematical practice.

In order to attain these outcomes BE's will also need to demonstrate:

- Knowledge as well as conceptual understanding of the mathematical content required to be competent educators in their relevant phase
- Knowledge of the structure, nature and methodology of the learning area of mathematics
- Knowledge and application of the new revised curriculum statement in mathematics relevant to their phase
- That they understand and can demonstrate various ways of solving mathematical problems to learners in their relevant phase
- Knowledge and application of applying an outcomes-based approach to the teaching of mathematics
- That they are able to prepare and implement a learning task design on any given mathematics topic for their relevant phase
- Knowledge and application of classroom assessment in mathematics relevant to their phase
- That they are able to use the internet as a source of information

4. WORKSHOPS

The workshops will take the form of discussions, reflections, assessments and feedback and presentations. Contact time will generally be restricted to two hours at a time.

5. ASSIGNMENTS

Assignments for the year will be issued and discussed during the sessions.

6. ASSESSMENT CRITERIA

Assignments will be accompanied by a marking rubric that clearly defines the assessment criteria.

7. GENERAL

Correspondence between students and myself is often carried out via email. Please therefore ensure that you regularly check your email so that you are up to date on requirements, class times, discussion topics etc. Articles or documents that you are required to read will also be sent out via email so that you can print them. Please keep all of these in a file so that you can refer back to them as necessary. When I have attended a lesson of yours, I will always provide feedback via email within 48 hours. You will then be expected to respond to this email, with your reflections on aspects of the lesson (as requested by me) as well as a proposed mark for the assessment. Please also try to do so within 48 hours of receiving my email.

8. INDIVIDUAL APPOINTMENTS

You will each be requested to have an individual appointment with me sometime during your specialisation to discuss various aspects of being mathematics educator, with regard to your specific phase, needs, expectations etc. Please feel free to ask any questions during this meeting or to discuss any issues you would prefer not to work through in any of the group sessions. Please come and see me sometime in order to book a time (approximately 45 minutes) when this meeting can take place.

ENJOY the CHALLENGE!

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

UNIVERSITY OF PRETORIA
Faculty of Education

Professional Curriculum

Study Manual
for

Professional Portfolio
PPF (400)

LIFE CAN ONLY BE UNDERSTOOD BACKWARDS:
BUT MUST BE LIVED FORWARDS.
Sören Kierkegaard

Prof D M de Kock
Johannes A Slabbert

Revised and Updated December 2003

Disclaimer

Please take note that any part or the entire Study Manual may change at any time due to the rapid change and development of education in South Africa and worldwide and the fact that this entire programme is at this stage subject to research and in that regard a developing programme. However, you will be informed of the changes in good time so as not to have any negative influence on your own professional development as facilitators of learning.

A. ORGANISATIONAL COMPONENT

1. Professional Educator Information

Name	Prof DM de Kock	Prof Johannes A Slabbert
Building	Aldoel	Aldoel
Office number	E 214	F 205 A
Office tel no	420-2758	420-2773
Email address	dmdekock@hakuna.up.ac.za	jslabber@hakuna.up.ac.za

2. Sources

KORTHAGEN FAJ (ed.) 2001 *Linking practice and theory* Lawrence Erlbaum Associates, Publishers London. Chapters to be announced

ASKEW & CARNELL 1998 *Transforming Learning: Individual and Global Change* Redwood Books London

3. Assessment

Ways of assessment in this project

Assessment comprises

- Self-assessment
- Peer assessment
- Cooperative learning assessment
- Assessment by lecturer.

of

- Tasks
- Assignments for classroom discussions
- Participation in discussion
- Teamwork
- Teaching practice observation and reflection
- Logbook
- Seminar presentation

Final assessment

Final assessment for awarding qualified teacher status is based on Project A

- presentation of a continuous assessment profile and
- the final, developmental profile exposing growth of practice theory construction.

Continuous assessment criteria are

- the quality participation in discussions
- the quality of questions
- the quality reporting of research and reflective practice
- the ability to analyse and construct theory
- the design and management of a logbook
- the quality of critical self assessment and peer assessment
- creative input, enthusiasm, problem solving skills and the ability to identify theoretical principles and construct a reliable facilitating learning theory

The final, formal examination

- based on interpretation and selection of the logbook entries to finally report and display on personal growth, understanding and knowledge of the professional educators task and constructed practice theory.

4. Timetable

See the official general timetable for the PGCE

5. Structure of the module

UNIT 1
PRACTICE THEORY?
LEARNING HOW TO REFLECT

UNIT 2
DOING ACTION RESEARCH

UNIT 4
Session 1
THE LOGBOOK ASSESSMENT

Session 2
THE LOGBOOK ASSESSMENT

UNIT 6
PRACTICE THEORY
SEMINAR

B. STUDY COMPONENT

Purpose of this Module

- To enable educators to analyse, discuss, evaluate and change their own practice adopting and analytical approach to facilitating learning
- To foster educators' appreciation of the social and political contexts in which they work, supporting them to recognise that facilitating learning is socially and politically situated and that the educator's task involves appreciation and analysis of context.
- To enable educators to appraise moral and ethical issues implicit in classroom practices, including the critical examination of their own beliefs about quality learning facilitation.
- To encourage educators to take greater responsibility for their own professional growth and to acquire some degree of professional autonomy;
- To facilitate educators' development of their own practice theory understanding and developing a principled basis for their own classroom work
- To empower educators so that they may better influence future directions in education and take a more active role in educational decision –making.

(adapted from Korthagen 2001:53)

STUDY UNIT 1

SESSION 1 PRACTICE THEORY? & SESSION 2 LEARNING HOW TO REFLECT

What is practice theory?
When is theory relevant?
Why a practice theory?
How do you construct a practice theory?

What is reflection?
When do you reflect?
Why do you reflect?
How do you reflect?

1. Learning outcomes

To fullfill the role of researcher and independent lifelong learner
To interpret concrete experiences and confidently motivate actions

2. Sources

KORTHAGEN FAJ (ed.) 2001 : Linking practice and theory Lawrence Erlbaum Associates, Publishers London.
Excerpts from Chapters 1 & 2.

3. Workshop

SESSION 1

Choose a topic and design an opportunity for learners to learn.

1 Sharing in groups by explaining your design
2 Group members listen and compose a list of questions
3 Using the lists of questions discuss the designs
4 Choose the best design.
Student 1:Describing the design to the whole group
Student 2:Motivating your groups choice.
Student 3:Indicate how it can be improved
Student 4:Indicate the principals governing the design that you as a group derive from this experience?

5 Information session
- Introducing the logbook.
- What is a Logbook?
- Short exercises to follow

6. Self-activity(s)

Using this experience of session 1 formulate answers to the questions asked at the beginning of this unit in your logbook

7. Assignment(s)

Read, analyse and interpret the prescribed notes. Indicate what relation it has to the workshop activities.
Give a one page written report in your logbook.

SESSION 2

Compiling Assessment standards

- Groups set the assessment standard
- Peer assessment of assignments in groups
- Individual students list what they have learnt from this session.

Is reflection action learning?

- Whole group discussion

Study the following

- ASKEW & CARNELL 1998 Transforming Learning: Individual and Global Change Chapter 5

How do you reflect?

- Compile a definition for reflection?
- Design your own model for reflection?

Final assignment for this Unit

Study

- KORTHAGEN's Notes taken from Chapter 7, 8 & 11 then critically analyse and compare his reflection model to the one you have designed.
- Record your insight in your Logbook

UNIT 2
DOING ACTION RESEARCH

What distinction is there between action learning and action research?
What is action research?
How do I do action research?
Why do I do action research?
What evidence can be used?

1. Learning outcomes

To fulfill the role of researcher and independent lifelong learner
To create a vehicle for professional development
To operate with confidence in the context of the classroom, learning and education as a whole.

2. Sources

KORTHAGEN FAJ (ed.) 2001 : *Linking practice and theory* Lawrence Erlbaum Associates, Publishers London.
Excerpts from Chapters 11
ASKEW & CARNELL 1998 *Transforming Learning: Individual and Global Change* Chapter 5 and 9
Notes to be handed out

3. Workshop

Does action research bring about changes in your practice?
Do you gain confidence through action research ?
How are you going to prove this?

a. Self-activity(s)

Design your action research for term 2 at the schools
Plan how you are going to record your work?

b. Assignment(s)

Implement your action design during term 2
Reflect continuously using the model you have designed in Unit 1
Conclude with an essay on your constructed knowledge supported by a practice theory
Prepare your logbook for assessment during the June contact sessions

c. Assessment standard

Clarity, logic, evidence, reliability, insights, quality management, relevancy, understanding

ADDITIONAL LEARNING MATERIAL

PRACTICE THEORY

What it is:

- The "practice" (Afr. praktyk) in practice theory refers to your education practice (Afr onderwyspraktyk. What you do when you are preparing to facilitate learning (LTD) and when you are actually facilitating learning (LTO).
- The "theory" in practice theory refers to the body of systematised knowledge about and for your practice as facilitator of learning.
- Your practice theory is therefore the theory of your practice derived primarily from your practice (it is a theory).
- It is continuously informed and enriched by your practice as such (through reflection on your practice and action research of your practice) but also other practices of other facilitators of learning as well as other already existing theories (research) in education.
- It is therefore in a continuous process of development.

What its function is:

- Your practice theory is the foundation from which you operate in practice.
- It tells you what to do and how to operate in practice.
- It therefore determines all your actions in your practice.
- It provides all the reasons why you are operating in practice the way you do.
- It provides the rational for what you are doing as facilitator of learning.
- When you are asked questions about your practice you need to be able to explain everything in terms of your practice theory.

Practice theory in the format of a concept map (and explanatory notes)

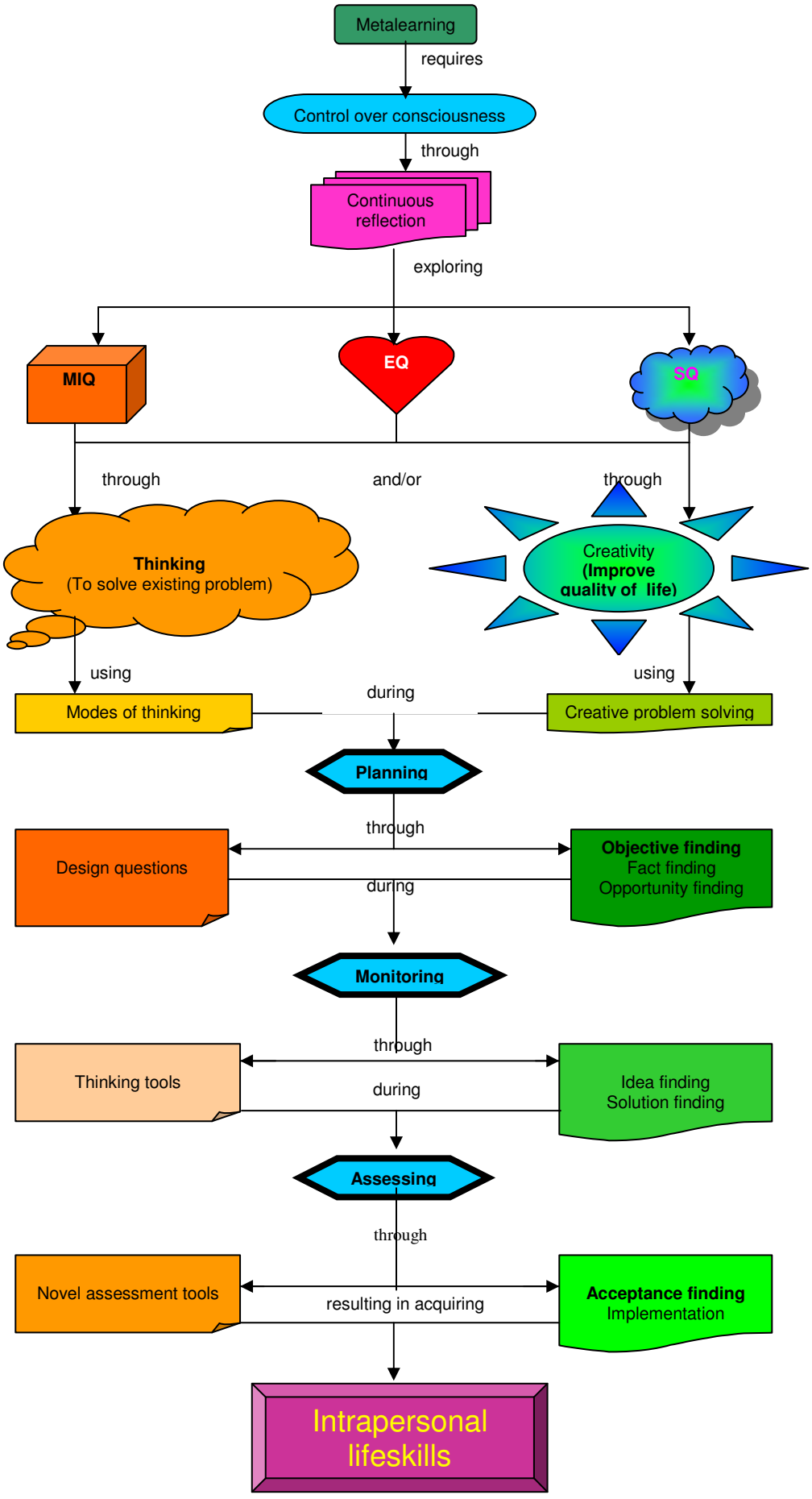
A concept map is a creative (colourful, playful, animated) construction of the relationships between a set of (selected) concepts indicating the nature, distance, and relatedness of the relationships between the concepts. A self-constructed concept map is reveals a learner's understanding of what the concept map represents (as opposed to a mind map). It reflects the differentiation between the concepts, as well as the nature and structure of the contextual relationships between the concepts as it manifests in an integrated meaningful whole. It reveals the learner's ability to construct meaning through identification, exposition and definition of distinguishable meaningful units, and recognising, discovering and creating relationships. The preceding paragraph is therefore self-explanatory regarding the reason why the requirement is that the practice theory should be constructed in the form of a concept map (with explanatory notes - where it becomes inevitably necessary).

To qualify as a concept map, the following criteria should be observed:

- A concept map consists of concepts – meaningful units which, in itself, has meaning.
- A concept map consists of at least two concepts.
- Each concept in a concept map has to be linked to at least one other concept by a line that indicates a relationship between the two concepts. Any one concept, however, may have a relationship with many other concepts.
- An arrowhead has to indicate the relatedness between the concepts. There may be a reciprocal relationship between two concepts that should be indicated by an arrowhead directed to each of the two concepts.
- The nature of the relationship between two concepts should be indicated with a written linking word on the linking line.
- The distance of the relationship should be indicated by the length of the linking line.

On the next page, a concept map of metalearning is depicted. Please note that the electronic medium has an unfortunate detrimental limiting consequence for the ultimate construction of a concept map regarding most of the criteria. Concept maps should rather be constructed on large poster size paper through low-tech means.

CONCEPT MAP OF METALEARNING



REFLECTION

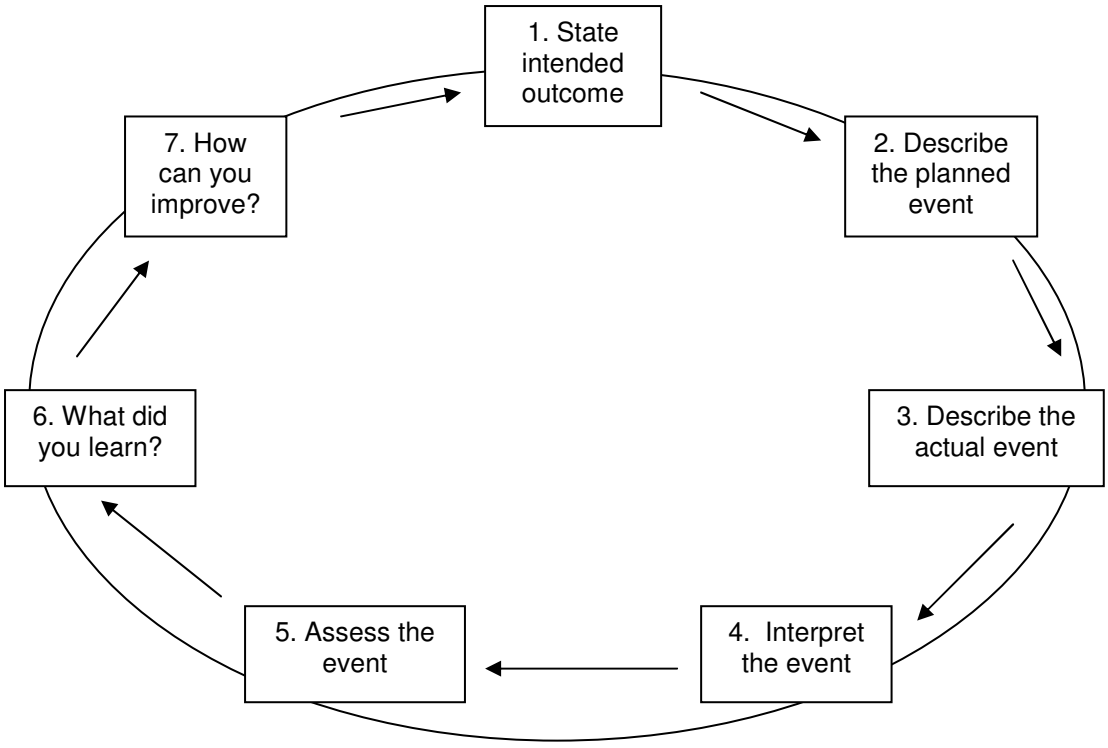
What it is:

- Reflection is a critical assessment conducted at the end of an event that you were part of or that you observed.
- The kinds of events that you will be doing reflection on during your education to become the best FOL you possibly can.
- But since your career is that of FOL, the major events that you will do reflection on would be how well you were facilitating learning.
- Reflection is of crucial importance for your professional development and is a meaningful stand-alone instrument for doing so.
- Reflection conducted on its own (outside the process of action research) is a critical assessment of a practice episode ***through your own subjective observations***.
- Action research always includes reflection: Reflection then is conducted ***only on the data you have collected***.

The process of reflection:

- State the intended outcome: What did you want to achieve?
- Describe the planned event for achieving the outcome: How did you want to achieve it?
- Describe the actual event: What did actually happen?
- Interpret the event: Why did it happen?
- Assess the event: Was what happened good or bad regarding the intended outcome?
- What did you learn?
- How can you improve?

THE REFLECTION PROCESS



ACTION RESEARCH

What it is:

- The "research" in action research indicates that it is a RESEARCH process of systematically gathering the most appropriate DATA for providing HARD evidence of the actual reality of what you are investigating (and not simply the reality as you have subjectively observed it by yourself).
- The "action" in action research refers to action being taken by you to improve a particular aspect of your practice.
- The "action" in action research is taken in a continuous (cyclic) process of PLAN, ACT, OBSERVE, REFLECT, REVIEW which, at the same time, results in the new PLAN that restarts the process. This process is then taken through a number of such phases (cycles).
- You are challenged to take your action research through at least 4 such cycles (phases)

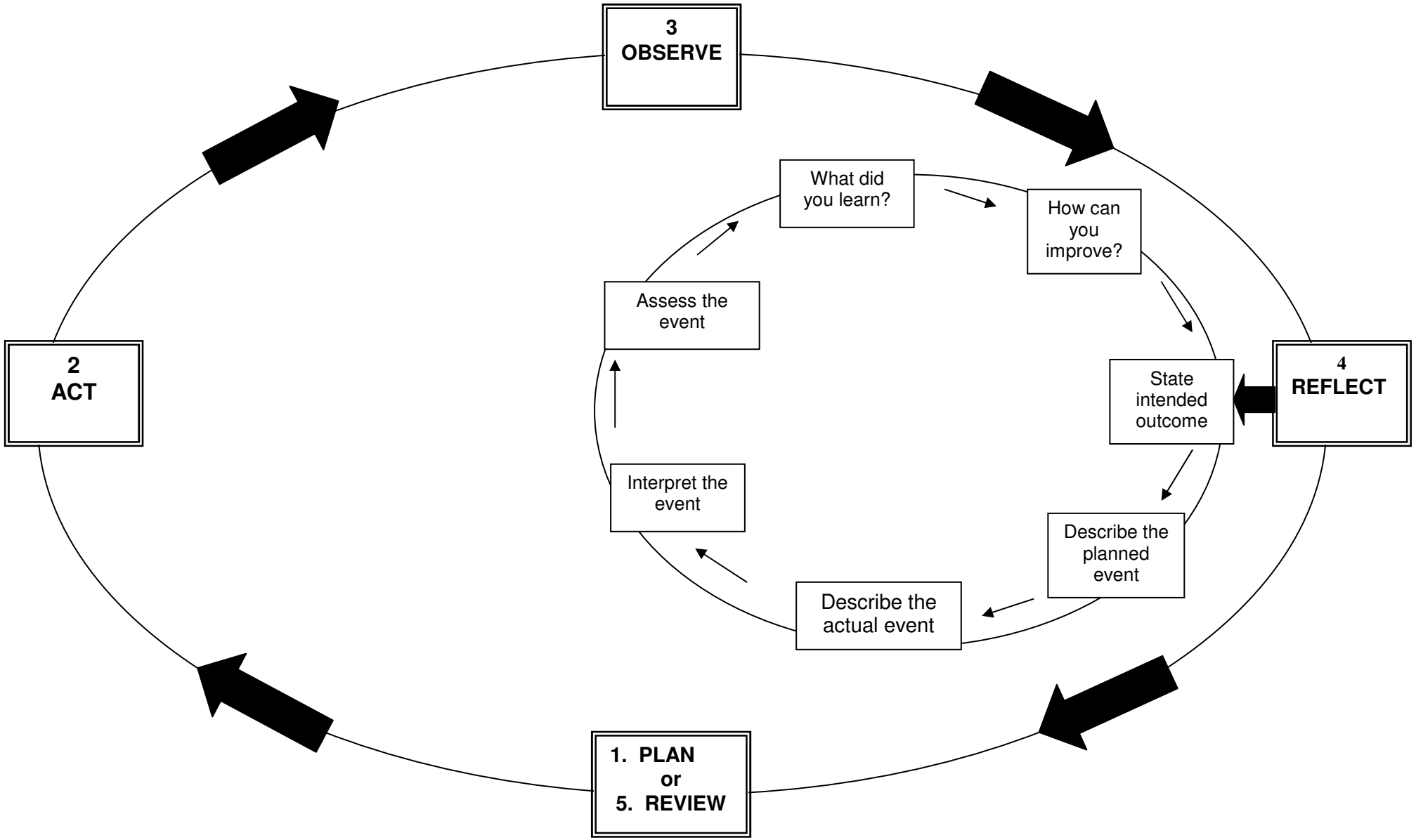
The process of action research:

- PLAN what particular aspect of your practice you want to improve on through action research (During this term it would be your LTF of maintaining learning): What, how, when, where, and why?
- ACT by executing your plan.
- OBSERVE in this context means to collect your data while you are executing your plan (During this term it would be the data you are collecting to determine how well you are executing your LTF of maintaining learning). You may have, and in some cases it may be necessary to have someone else collect your data for you. The way in which your data is collected should also represent a proper classification thereof. If this is not the case, you need to classify your data after it has been collected.
- REFLECT through conducting a critical assessment ***only of the data you have collected!***
- REVIEW your original plan according to the result of your reflection indicated by the data you have collected and adapt your plan to improve your performance (of your LTF during this term) accordingly. RESTART commences with the reviewed plan as the starting point of the next cycle (phase).

How you should conduct your action research:

- You are likewise advised to make video recordings as a means through which to collect your data. This will result in at least 4 video recordings corresponding to 4 LT's and 4 learning periods.
- You are advised to video record your initiating learning together with your maintaining learning for a particular LT for the length of at least one learning period, which will include your LTF. The reason for this is to retain the appropriate LT context and not to video record only your maintaining learning part in isolation. However, you need to ensure that the length of the recording of your maintaining learning part is sufficient to provide enough data for trustworthy evidence for your LTF. Video record a consecutive learning period of your LTF if there is a possibility that you may not have collected enough data in one learning period.
- In the unlikely but possible event that you will initiate less than four LT's, you are advised to video record the necessary amount of consecutive learning periods of your maintaining learning to ensure that an appropriate amount of data for your LTF is collected.

ONE CYCLE (PHASE) OF ACTION RESEARCH



PROFESSIONAL DEVELOPMENT

- It is your development for IMPROVEMENT.
- It consists of an increase of knowledge of WHAT and HOW.
- But much more importantly, it consists of an increase in the knowledge of WHEN, WHERE, WHY and WHAT IF.
- It therefore consists of the ***internalisation*** of PRNICPLES determining your actions.
- These principles recognised by the fact that it gives direction for continuous increased improvement.
- The development is professional in that it demonstrates an implementation of the internalised principles through a continuous increased improvement which cannot be accomplished by someone else outside the profession.

Appendix C - Paradigms of learning

FOUR EDUCATION PARADIGMS / *VIER ONDERWYSPARADIGMAS*

ONDERWYSPARADIGMA EDUCATION PARADIGM / EDUCATION COMPONENT *ONDERWYSKOMPONENT*	**Transmission** *Transmissie*	**Transaction** Transaksie	**Transformation** Transformasie	**Transcendental** Transendensie
Aim **Doel**	To impart knowledge *Om kennis oor te dra*	To understand *Om te verstaan*	To apply knowledge *Om kennis toe te pas*	To generate knowledge *Om kennis te genereer*
Education mode **Onderwysmodus**	Direct teaching *Direkte onderrig*	Interactive teaching *Interaktiewe onderrig*	Project education *Projekonderwys*	Facilitating learning *Fasilitering van leer*
Focus **Fokus**	Factual knowledge *Feitelike kennis*	Factual understanding *Verstaan van feite*	Application *Toepassing*	Creative construction of meaning (knowledge) *Kreatiewe konstruksie van betekenis (kennis)*
Educator action **Onderwyseraksie**	Tell, illustrate, demonstrate, explain *Vertel, illustreer, demonstreer, verduidelik*	Questioning, discussing *Vraagstelling, bespreking*	Give assignments, projects, guidance, help *Gee opdragte, projekte, leiding, hulp*	Confront the learners with a real life challenge they have to resolve themselves *Konfronteer leerders met 'n lewenswerklike uitdaging wat hulle self moet oplos*
Learner action required **Leerderaksie verwag**	Absorb, memorise, drill, practice *Absorbeer, memoriseer, dril, inoefen*	Answering questions, discussing *Beantwoord vrae, bespreek*	Exploration, discover, experimentation, *Eksploreer, ontdek, eksperimenteer*,	Creatively constructing new knowledge *Kreatiewe konstruksie van nuwe kennis*
Learning mode **Leermodus**	Receptive *Reseptief*	Interactive *Interaktief*	Self-active *Selfaktief*	Self-directive *Selfgerig*
Learner autonomy **Leerder outonomie**	None *Geen*	Some *Min*	Much *Heelwat*	Total *Totaal*
Level of learning **Vlak van leer**	Shallow *Vlak*	Insight *Insig*	Deep *Diep*	Transcendental *Transenderend*
Learning outcome **Leeruitkoms**	Cognitive Kognitief	Social *Sosiaal*	Multiple *Veelvuldig*	Holistic *Holisties*
Outcome **Uitkoms**	Core concept reproduction *Kernkonsepreproduksie*	Core concept understanding *Kernkonsepbegrip*	Enriched curriculum *Verrykte kurrikulum*	Living real life *Leef die werklikheid*
Learning quality **Leerkwaliteit**	Low *Laag*	Medium *Medium*	High *Hoog*	Maximum *Maksimum*

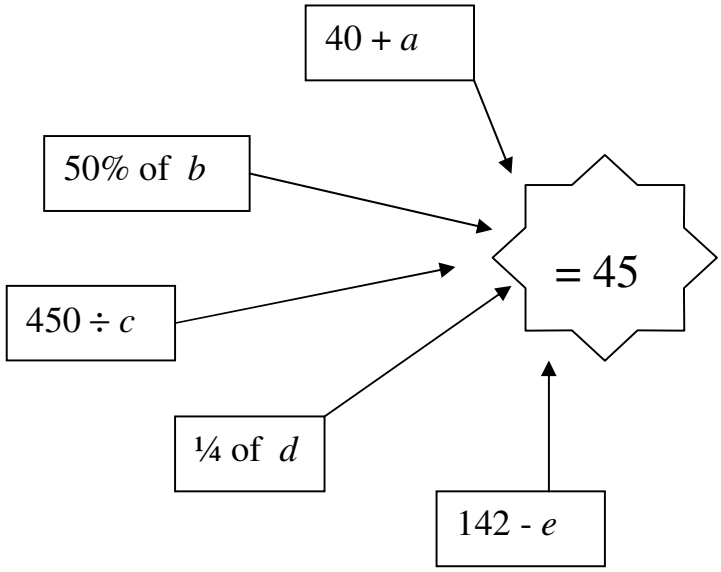
Appendix D - Baseline mathematics assessment

UNIVERSTIY OF PRETORIA – EDUCATION FACULTY
PGCE BASELINE ASSESSMENT

The following exam was set for a Grade 10 Mathematical Literacy class. You are required to set the memorandum for the exam. You are not permitted to use a calculator in setting up the memorandum. Please remember to include your name on the memorandum. You have two hours in which to complete this.

QUESTION 1

a) Write down a number to replace each letter so that the answer is **always 45.**
For example: $a = 5$



(4)

b) Calculate:

(1) $-1^2 \times (-5)^2$

(2) $6^2 + (-1)^2$

(3) $-1\,023 - (-248)$

(4) $-902 + (-65)$

(5) $\sqrt[3]{-216}$ (5)

c) Write down the decimal form of $21\frac{1}{4}$ (1)

d) Write the decimal 1,4 as a fraction (1)

e) Simplify: (2)

$$7-\left(2\frac{1}{4}+1\frac{1}{3}\right)$$

f) Write down whether the following statements are TRUE or FALSE:

(1) 12 is a multiple of 24.

(2) 1 is an even number.

(3) 26 is a multiple of 13.

(4) The product of 11 and 10 is 110.

(5) $x + x + x = 3x^3$

(6) a x $3a = 3a^2$

(7) $x = \frac{1}{2}$ if $14x = 7$

(7)
[20]

QUESTION 2

a) Write the letter of the correct expression next to the matching number:

(1)	x increased by 10	A)	xy
(2)	The product of x and y	B)	$x \div 2$
(3)	The sum of a certain number and double that number	C)	$x - 2$
(4)	Half of a certain number multiplied by itself	D)	$½\, x^2$
(5)	Ms Barnes' age in x years' time	E)	$35 + x$
(6)	Two less than x	F)	$x + x + 2$
(7)	A certain number multiplied by itself	G)	x^2
(8)	Two consecutive even numbers	H)	x^{35}
(9)	$x + x + x +$ …… to 35 terms	I)	$x + 2x$
(10)	$x.x.x.x.x$….. to 35 factors	J)	$x + 10$
		I)	$35x$

(10)

b) Simplify the following expressions:

(1) $-2x - 7x$ (1)

(2) $-3y + 2x + 11y - 8x$ (2)

(3) $(-5a)(-a)^2$ (2)

(4) $10^4 + 10^4 + 10^4 + 10^4 + 10^4$ (2)

(5) $2^3 \times 2^2$ (1)

(6) $-5p \times 6q \times (-2p)$ (2)

(7) $5x^2 - (-7x^2) + x^2$ (2)

(8) $-x^2 + 3x - 5x^2 - x$ (2)

(9) $2(x + 1) - (x - 2)$ (3)

(10) $(-5 + 2)(-3 - 4)$ (2)

(11) $\dfrac{4x^3y^4}{8x^2y^5}$ (2)

(12) $\dfrac{2x}{6} + \dfrac{x}{2}$ (2)

(13) $\dfrac{-3x^2 + x^3 - x}{x}$ (3)

(14) $[-2(2a^2b^3)]^2$ (2)

(15) $4y^0 \times \left(\dfrac{y}{2} + \dfrac{y}{4}\right)^2$ (4)

[42]

QUESTION 3

a) The following equation was solved by a Grade 9 learner. Rewrite the equation into your exam scripts and circle any mistakes (there may be more than one). Then redo the equation correctly:

$-2(x + 1) - 2 = x + 1$
$\therefore -2x + 2 - 2 = x + 1$
$\therefore \quad -2x = x + 1$
$\therefore \quad -2x + x = x + x + 1$
$\therefore \quad -x = 1$
$\therefore \quad x = -1$ (5)

b) Solve the following equations:

(1) $x + x + x + x = 12$ (1)
(2) $x.x.x = 27$ (1)
(3) $2x - 8 = 4$ (1)
(4) $4x + 7 = 9$ (2)
(5) $-3x + 10 = 3x - 14$ (3)
(6) $2 - 2(x - 2) = -3(x + 4) + 1$ (5)

c) If $x = 2$ is the solution to an equation, make up any equation to suit this solution. (2)

d) Solve for a and b:

a x a x b x b = 36 (2)

e) Two numbers, m and n are multiplied to give an answer of -12; that is m x n = -12

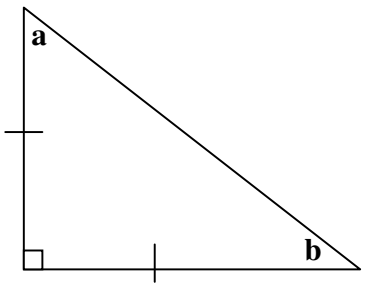
(1) If m is 3, what must n be? (1)
(2) Write down all the integer/*heelgetalle* values that m and n can have? (3)
(3) If m is 0, will there be a value for n that can make the equation true? Explain your answer. (2)

[28]

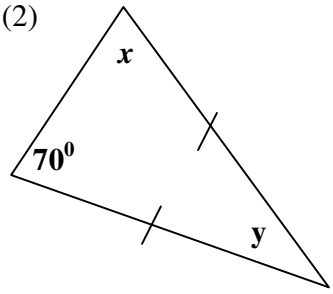
QUESTION 4

a) Calculate the sizes of the angles marked with small letters:

(1)

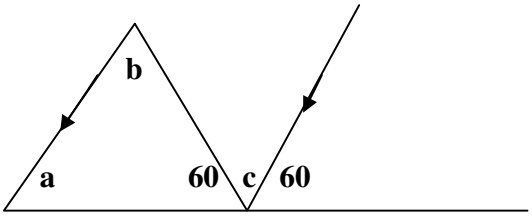


(2)

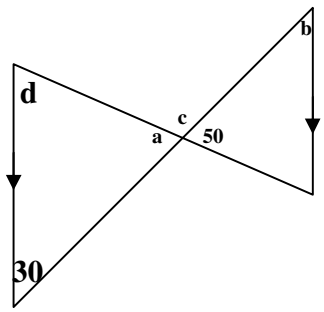


(2)

(3)

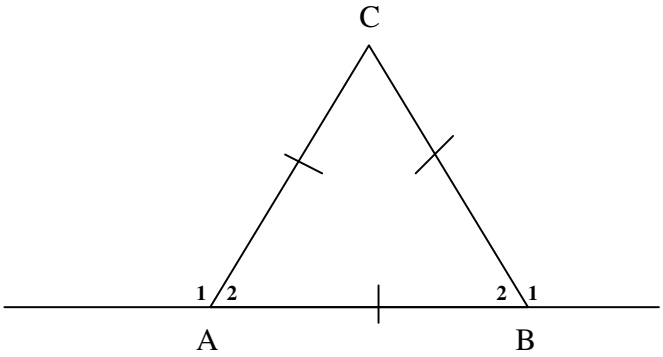


(4)



(3) (4)

b) Calculate the value of the missing angles in the following sketch and provide reasons for your answers.



(6)

c) The following triangle is a right-angled triangle.

AB is equal to 12. AC is equal to 16. B = 90°

(1) Draw the triangle and label it correctly. (2)
(1) Calculate BC, correct to two decimal places. (2)
(2) Calculate the perimeter/*omtrek* of the triangle. (2)
(3) Calculate the area of the triangle. (2)

[25]

QUESTION 5

a) Fill in > ; < or =

(1) -18 _____ 18

(2) $-4x$ _____ $-11x$

(3) 1.5 _____ 0.15

(4) $\frac{10}{10}$ _____ 1

(5) $3\frac{1}{2}$ _____ $\frac{7}{6}$ (5)

b) Answer the following questions:

(1) Change $\frac{18}{30}$ into a percentage. _____ (2)

(2) A shirt costs R108 but the store manager offers you 10% discount. What must you pay for the shirt? (2)

_____

c) If 1 cm represents 20 m,

(1) how many metres will 15 cm represent? (1)

(2) how many centimetres must you draw to represent 200 m? (1)

d) Find the formula for the following:

(1)

x	*y*
2	4
3	6
4	8

y = _____ (2)

(2)

x	*y*
2	5
3	6
4	7

y = _____ (2)

[15]

QUESTION 6

A scientist is comparing the weights of the four molecules listed in the table below:

WEIGHTS OF MOLECULES

Molecule	Weight (in kilograms)
Salt	9.350×10^{-28}
Pure water	2.879×10^{-26}
Hydrochloric acid	5.832×10^{-22}
Potassium hydroxide	8.976×10^{-24}

Which of these molecules is the heaviest? **[1]**

QUESTION 7

A wholesaler is offering two different package deals of roses and carnations to florists. One package contains 20 dozen roses and 34 dozen carnations for R504.00. The other package contains 15 dozen roses and 17 dozen carnations for R327.00. This information can be represented by the system of equations below, where r represents the cost of one dozen roses and c represents the cost of one dozen carnations.

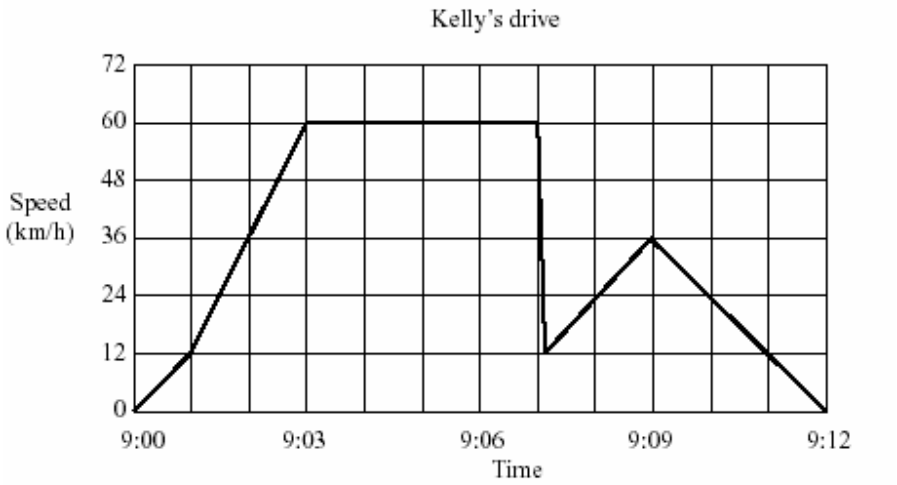
$$20r + 34c = 504$$

$$15r + 17c = 327$$

Solve the system of equations to find the cost, in rands, of a dozen roses. **[4]**

QUESTION 8

Kelly went for a drive in her car. During the drive a cat ran in front of the car. Kelly slammed on brakes and missed the cat. Slightly shaken, Kelly decided to return home by a shorter route. The graph below is a record of the car's speed during the drive.



a) What time was it when Kelly slammed on the brakes to avoid the cat? (1)

b) Explain what you think was happening between 9:03 and 9:07 according to the graph. (2)

[3]

QUESTION 9

A school club is planning a bus trip to the Kruger National Park. A bus which will hold up to 45 people will cost R1500 to hire and the daily admission into the Park is R30 each. If the cost of the trip, including bus and admission ticket, is set at R80 per person, what is the minimum number of people who must participate to ensure that the costs are covered? **[2]**

QUESTION 10

The following two advertisements appeared in a newspaper in the country "Zorbodia" where the currency used are *zeds*.

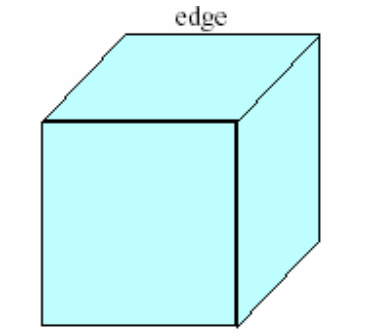
BUILDING A	BUILDING B
Office space available 85 - 95 square meters 475 *zeds* per month 100 - 120 square meters 800 *zeds* per month	Office space available 35 - 260 square meters 90 *zeds* per square meter per year

If a company is interested in renting an office of 110 square metres in Zorbodia for a year, at which office building, A or B, should they rent the office in order to get the lower price? Explain your answer.

[4]

QUESTION 11

This picture shows a cube with one edge marked. How many edges does the cube have altogether?



[2]

QUESTION 12

The figure consists of 5 squares of equal size. The area of the whole figure is 405 cm^2.

a) Find the perimeter of the whole figure. (2)
b) Find the length of one side of one square. (2)
[4]

Final total: **[150]**