



The role of learning functions in the shaping of new kinds of Mathematics teachers

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Orientation

Literature highlights the following:

- Under-achievement and poor achievement in Mathematics (Maree, Molepo, Owen & Ehlers, 2005; Van der Walt & Maree, 2007; Singh, Granville & Dika, 2002; Winicki-Landman, 2001).
- Learners do not understand mathematical concepts and cannot apply the concepts (Mwakapenda, 2004; Sternberg, 1999)
- Poor performance in the TIMMS and TIMMS-R – learners' mathematical knowledge is poor (Maree *et al.*, 2005; Reddy, 2005)

Factors that impact on learner achievement

Literature highlights the following:

- Motivation (Pintrich & Schunk, 2002)
- Expectations and self-worth (Folk, 2006)
- Attributions (Woolfolk, 2004)
- Goal orientation (Pintrich & Schunk, 2002)
- Self-regulation (Ertmer & Newby, 1996; Woolfolk, 2004)
- Quality learning environments (Folk, 2006)

The acquisition of learning functions is not mentioned as a factor that can influence learning and achievement



**In this presentation we argue:
The quest for effective teaching
and learning in order to enhance
academic achievement depends
on**

A proper balance between teaching and learning

Linking teaching to learning functions

The place of learning functions during teaching and learning

In order to determine the place of learning functions during teaching and learning the concept “LEARNING” needs to be explored further.

1. Learning is goal oriented

2. Learning is linking information to prior knowledge



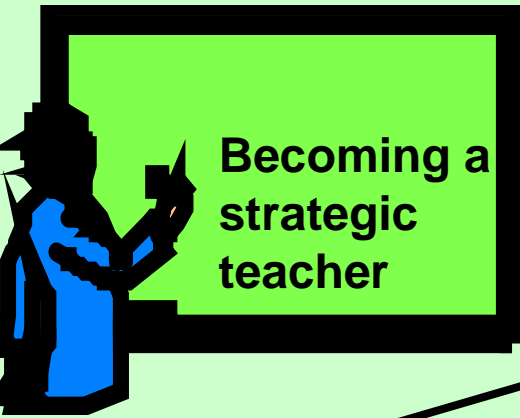
6. Learning is influenced by development

What is learning?

3. Learning is organizing information

5. Learning occurs in phases, yet non-linear

4. Learning is acquiring cognitive and meta-cognitive learning skills, functions and strategies



Procedures for linking teaching to learning

Thinking and making decisions

1. Aligning the variables of instruction

2. Relating content and instruction to learning

3. Developing effective skill/function and instruction strategies

4. Relating assessment to learning and instruction

5. Considering contextual constraints

Critical/core functions

1. Expectations
2. Motivation
3. Prior knowledge activation
4. Attention
5. Encoding/ Decoding
6. Feedback
7. Planning
8. Monitoring
9. Evaluation

Learning functions:

Mental activities that need to be applied to learning tasks

Functions that go beyond memorizing information

(Shuell & Moran, 1994)

Specific functions

1. Comparison
2. Hypothesis generation
3. Synthesis
4. Classify
5. Summarize
6. Infer
7. Explain
8. Apply
9. Analyze

Learning functions for mastering Mathematics

The MATH taxonomy of Smith *et al.*(1996)

Students should be challenged to develop knowledge and skills in

Group A

- Factual knowledge
- Comprehension (of factual knowledge)
- Routine procedures

Group B

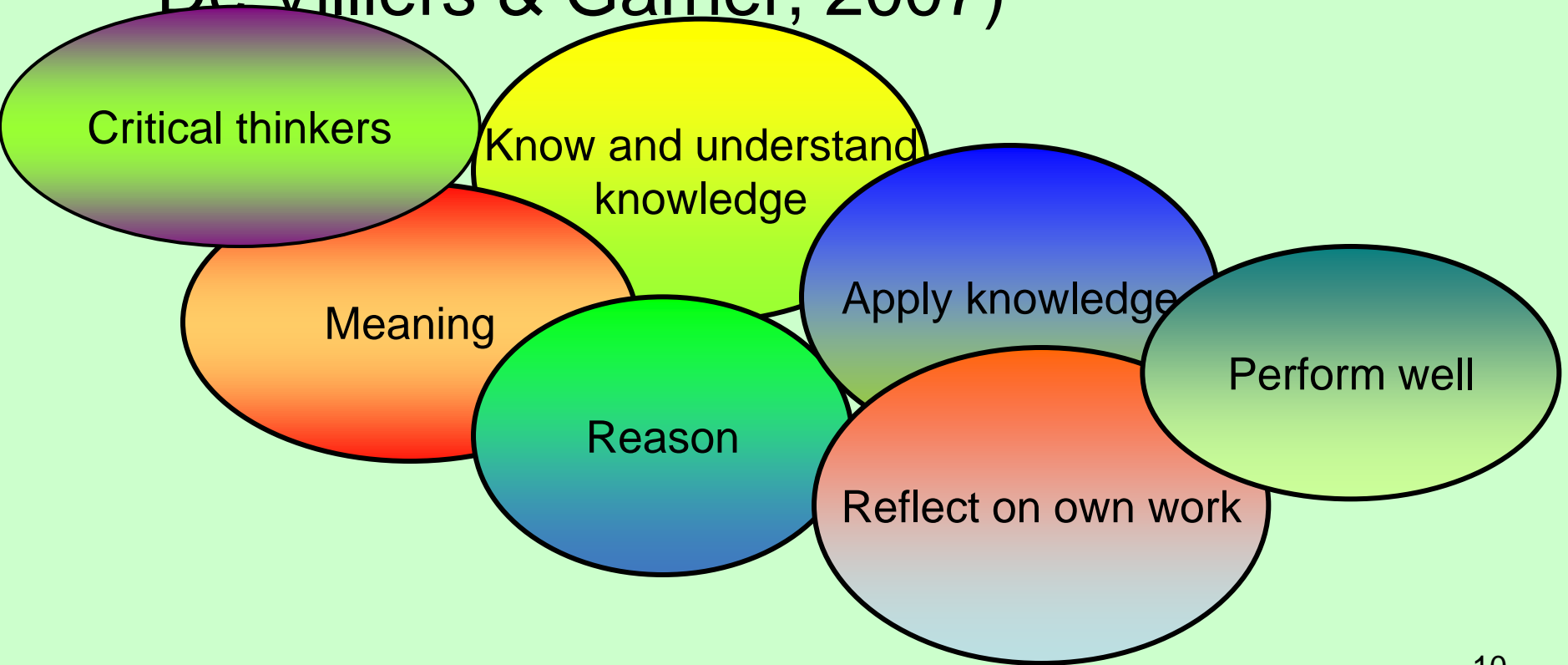
- Information transfer
- Application to new situations

Group C

- Justifying and interpreting
- Implications, conjectures and comparisons
- Evaluation

Expectations

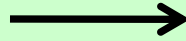
(+ Le Roux, Olivier & Murray, 2004;
Winstead, 2004; Lang, 2005; Xin, 2005;
De Villiers & Garner, 2007)



Learning functions addressed in the study

- Decoding of information
- Synthesizing and integration of information
- Comparing information
- Application of information
- Generating hypothesis
- Reflection (planning, monitoring and evaluation)

The importance of
learning functions



Independent
Confident
Active
Life long learners



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graph TD; Research((Research)) --> Aim[Aim]; Research --> Method[Method and design]; Research --> Data[Data Collection]; Research --> Population[Population and sample];
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Research

Aim

To determine if the acquisition of learning functions can improve achievement in Mathematics

Method and design

- Literature study
- Mixed method (embedded)
- Qualitative (focus)
- Quantitative (True experimental research: post-test alone control group design)

Data

Collection:

Observations
Testing
Assignments
Final exam

Population and sample:

All prospective teachers with Mathematics as major subject

Convenient sample:

2008 1st year students
With Mathematics as
Major at NWU:VTC
(n = 23)

Statistical Techniques:

Descriptive and Inferential statistics
Content analysis



Intervention programme

Implemented to teach students how to apply the functions
(Schoenfeld, 1985 & 1994; Polaya, according to Macintyre,
2006)

8 weeks - 1h per week

- Only experimental group guided
- Completed questionnaires
- Completed worksheets
- Made summaries of content

Both groups did same:

- Content
- Assignments
- Tests
- Exam

Learning functions were taught as follow:

Decoding

- Read more than once
- Distinguished between relevant and irrelevant
- Make comparison between prior and new knowledge
- Give own meaning to new content (write in own words)

Structured questionnaire

- Did you read information more than once
- Underline or encircle the words you think are important
- Write information in own words
- Give the knowledge you think you are going to use to solve problem

Synthesizing and integration

- Make a topic (section) their own
- Identify important aspects
- The meaningful combination of different information aspects to apply to new knowledge

Activities

- Summarize topic – use own method
- Feed back given

Comparing

Identify similarities and differences between concepts, definitions and different topics

Activities

- Summarize/ write down (with motivation)

Application

- Understand problem
- Construct mathematical argument from verbal
- Predict answer
- Make a plan to solve problem
- Identify knowledge needed
- Test answer (making sense)

Structured questionnaire

- What is asked?
- Where are you going to start?
- Which concepts are important?
- How are you going to solve problem?
- Identify the concepts you understand well.
- With what do you still have problems?

Generating hypothesis

- Identify assumptions in problems – motivate
- Predict answer – motivate
- Prove validity of assumption

Reflection

Planning

- Construct plan
- Identify knowledge needed

Monitoring

- Make sure understand question – motivate
- Use correct method to solve – motivate
- Make sure question is answered

Evaluation

- Identify and address misconceptions
- Motivate why answer is correct or not
- Identify strengths and weaknesses
- Able to apply knowledge again – motivate
- Find alternative method to solve problem

Data analysis

Observations

- Data was analyzed to determine patterns and themes
- Structured observation list used - how learning functions were addressed
- Only experimental group was observed
- 2 Observations per learning function

Data analysis Observations

Decoding

- Distinguished between relevant and irrelevant information problematic - improved
- Giving meaning to own knowledge - 1 student did not improve.
- Use of correct terminology - improved

Synthesizing and integration

- Most students found it difficult to combine different information aspects meaningful to apply to new knowledge
- Many improved

Comparing

- Identifying similarities and differences difficult - improved
- Discover own method

Generating hypothesis

- Identifying assumptions – improved
- Enjoyed to predict answer
- Prove validity of answer - problematic

Application

- Understanding problem problematic – many improved
- Construct mathematical arguments from verbal language problematic for all students – improved
- Making plan to solve problem – improved
- Identifying knowledge – improved
- Answer making sense - problematic

Reflection

- Identifying own misconceptions, strengths and weaknesses - improved
- Planning - improved some even creative
- Determine if answer is making sense - improved
- Motivation why answer is correct or not - improved
- Finding alternative method to solve problem - still problematic

Class discussions

- Gained confidence
- Reasoning improved
- Correct use of terminology improved

Data analysis

Tests, assignments & exam

Decoding

- Tests and assignments – all students progressed
- Few students showed a slight regression in exam

Synthesizing and integration

- Tests and assignments – all students progressed
- Exam – few students' performance slightly declined

Comparing

- Many students progressed

Application

- Tests and assignments – all students progressed
- Exam - many students showed regression
- Needs more guidance

Generating hypothesis

- Few students showed progression
- Needs more guidance

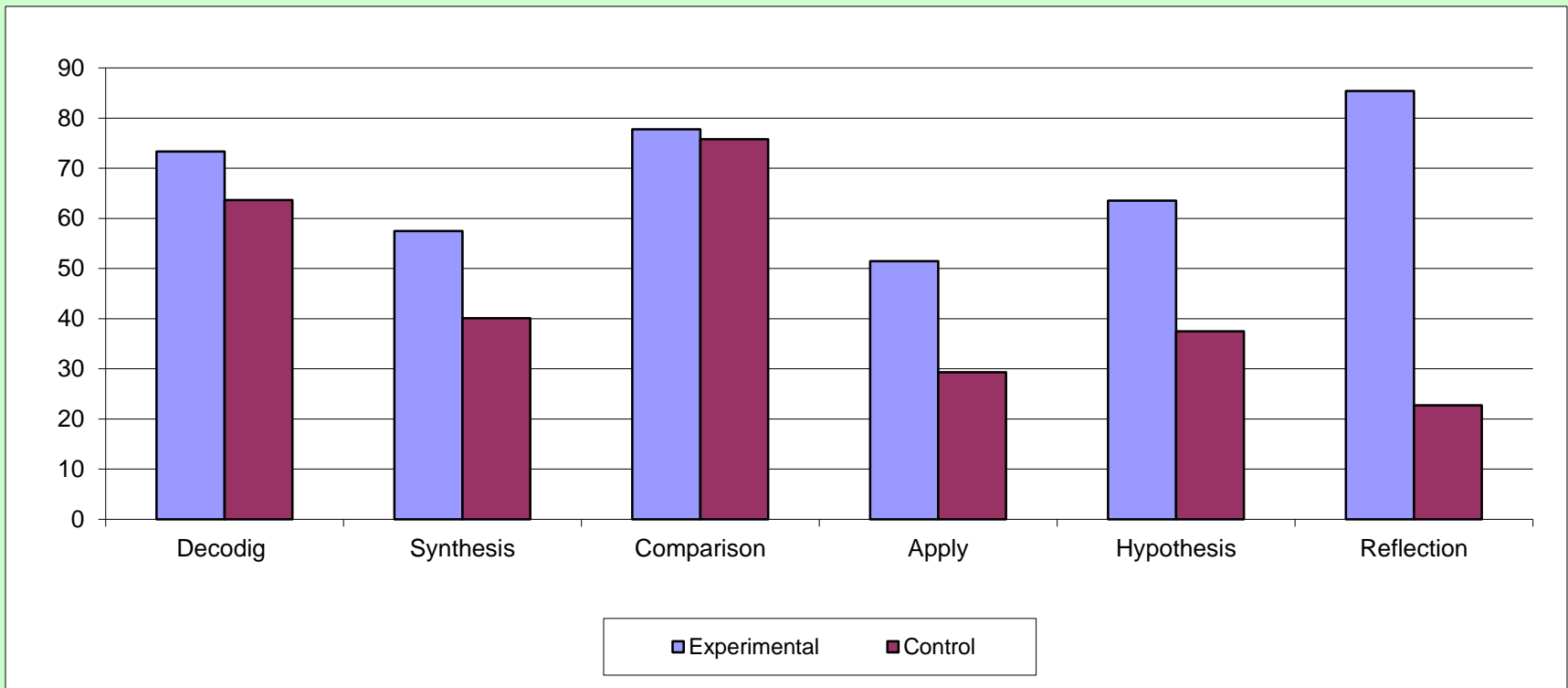
Reflection

- Many students progressed

Data analysis

Exam

Graph Exam Experimental & Control



Interpretation of Data

Observations

- Most students showed progression in the application of all learning functions
- Class discussions improved confidence and use of terminology
- Reasoning improved

Interpretation of Data

Post test (exam)

- Experimental group perform in all learning functions better than control group (graph)
- Statistical a significant difference between:
 1. Synthesizing and integration ($p=0,015$)
 2. Application ($p=0,042$)
 3. Reflection ($p=0,000$)
- Reason - Guided acquisition of learning functions?



Recommendations

- Teaching and learning of Mathematics must focus on more than good marks and a gateway to Higher-Education
- Guided acquisition of learning functions will create opportunities for learners to become what are expected
- Encourage learners to be more active in the mastering of their knowledge
- Teachers must guide learners more to develop own learning style

Conclusions

- A country's pride is its currency and reasoning the unit in which Mathematics are traded (Lijedahl, 2007)
- Encourage learners to reason with more boldness and confidence
- Guided acquisition of learning functions can improve academic achievement
- Shape new kinds of Mathematics teachers that can teach learning functions

THANK YOU