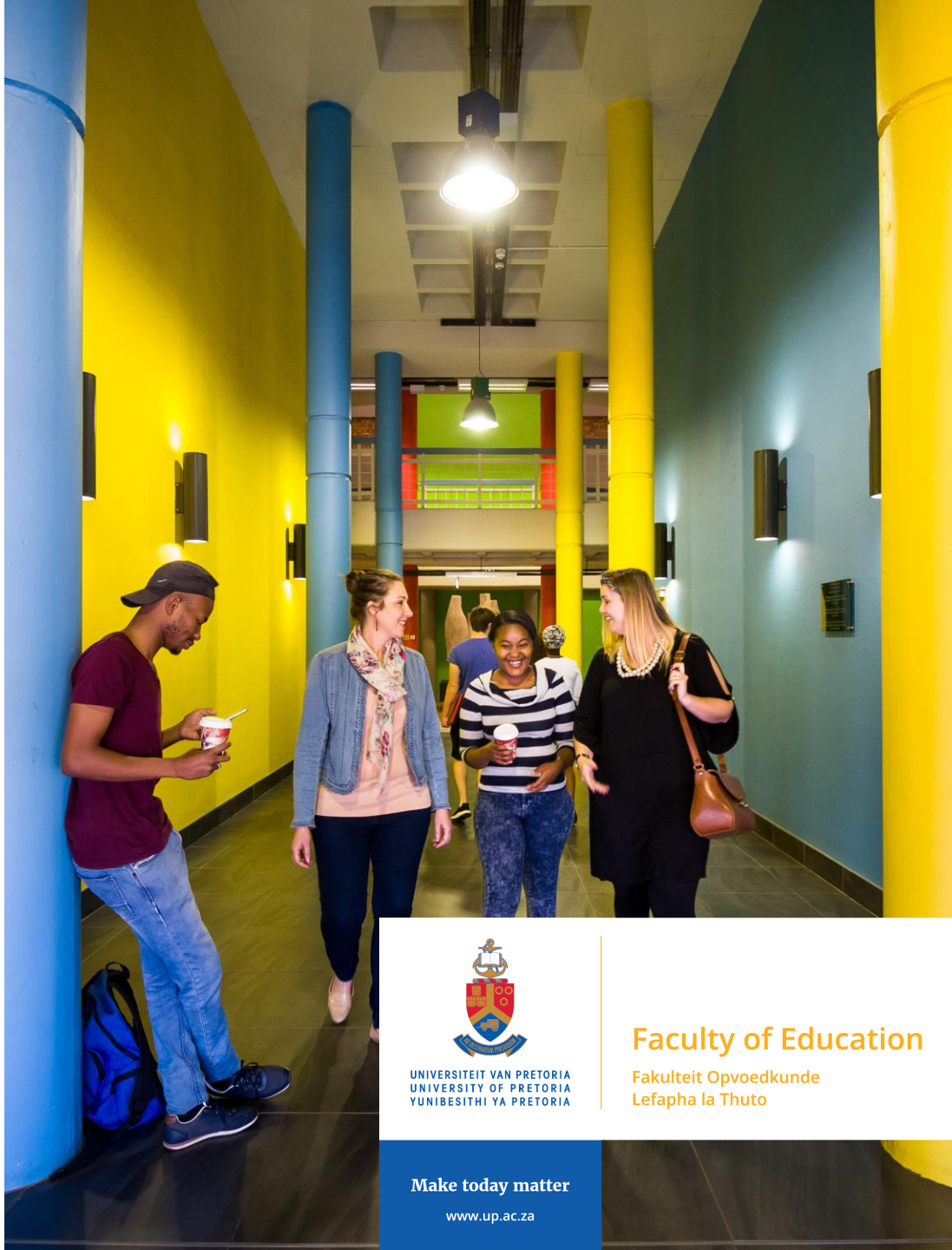
University of Pretoria
Pre-University Academy
(UP-PUA)

LEARNER EXPLANATIONS AS A WAY TO ENCOURAGE REFLECTIONS OF MULTIPLE SOLUTIONS TO TASKS

VASANTHA MOODLEY



Plan for the presentation

1. Introduction to the Study
2. Background of the PUA
3. Theoretical Framing
4. Methods
5. Findings
6. Discussion and conclusion

INTRODUCTION

"I have always been an "A" student in mathematics at primary and high school.

I obtained 98% in mathematics in grade 12.

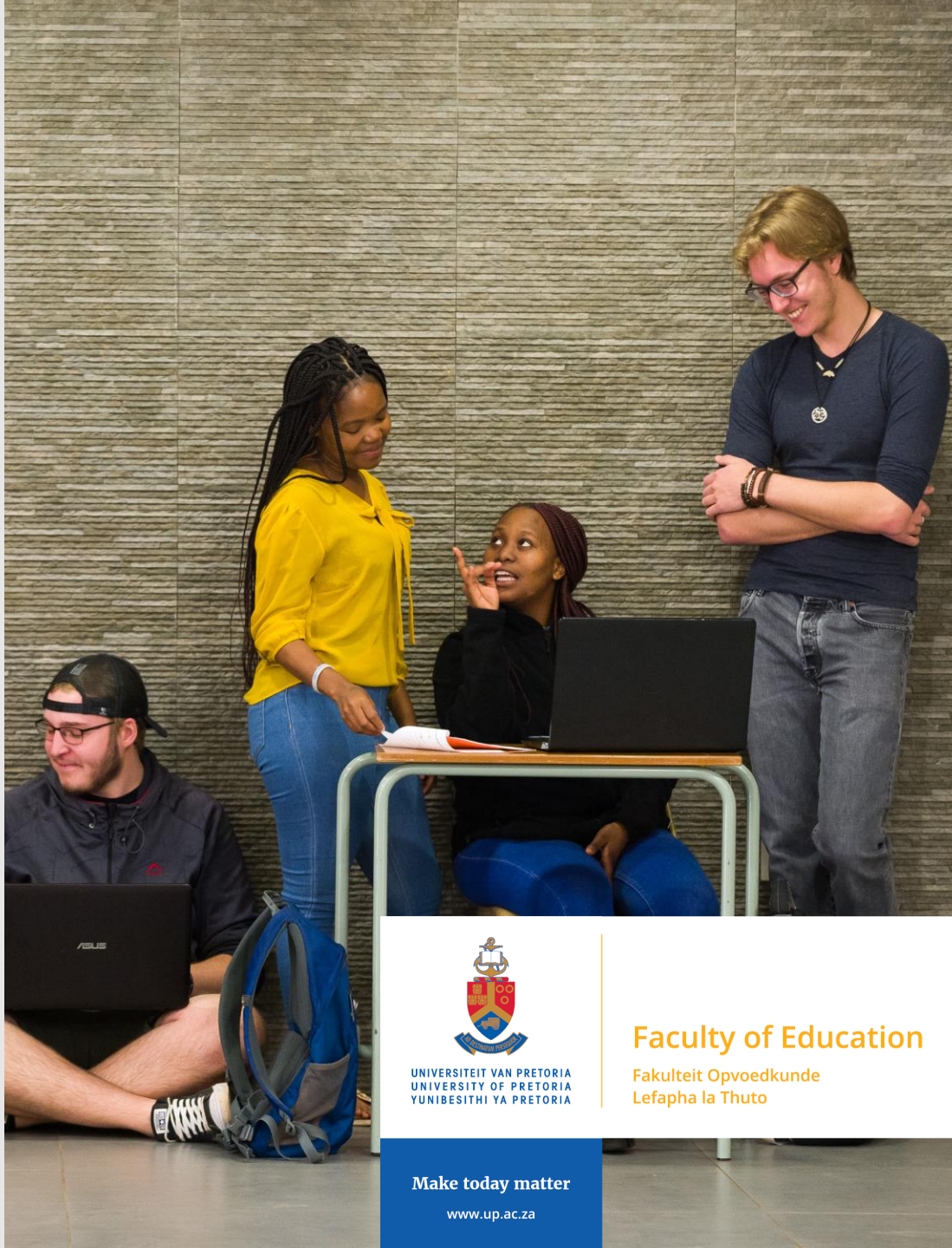
But none of the mathematics I learnt at school prepared me for mathematics at university.

I failed first year mathematics at university.

Ma'am how is this possible?"

(Lament from Paul* studied Actuarial Science at university)

*** Pseudonym**



BACKGROUND OF THE STUDY

- Poor return on SA government's budget on basic education(over 330 billion) - poor mathematics results.
- TIMMS study (2015) $\frac{1}{3}$ of SA GR 9 learners achieved at minimal level for mathematics (Reddy et al. 2020) .

Table 1: Mathematics performance across TIMSS 2015 countries

Country	Average Scale Score	SE
Singapore	621	(3.2)
Korea, Rep. of	606	(2.6)
Chinese Taipei	599	(2.4)
Hong Kong SAR	594	(4.6)
Japan	586	(2.3)
Russian Federation	538	(4.7)
Kazakhstan	528	(5.3)
Canada	527	(2.2)
Ireland	523	(2.7)
United States	518	(3.1)
England	518	(4.2)
Slovenia	516	(2.1)
Hungary	514	(3.8)
Norway (9)	512	(2.3)
Lithuania	511	(2.8)
Israel	511	(4.1)
Australia	505	(3.1)
Sweden	501	(2.8)
TIMSS Scale Centrepoint	**500**	
Italy	494	(2.5)
Malta	494	(1.0)
New Zealand	493	(3.4)
Malaysia	465	(3.6)
United Arab Emirates	465	(2.0)
Turkey	458	(4.7)
Bahrain	454	(1.4)
Georgia	453	(3.4)
Lebanon	442	(3.6)
Qatar	437	(3.0)
Iran, Islamic Rep. of	436	(4.6)
Thailand	431	(4.8)
Chile	427	(3.2)
Oman	403	(2.4)
Kuwait	392	(4.6)
Egypt	392	(4.1)
Botswana (9)	391	(2.0)
Jordan	386	(3.2)
Morocco	384	(2.3)
South Africa (9)	372	(4.5)
Saudi Arabia	368	(4.6)

- Mathematics teaching at SA schools direct teaching "chalk and talk" (Mabena et al., 2021) .
  - Focus on memorising and the recall of procedures - surface learning.
- UP-PUA - Poor performance lack of deeper understanding in mathematics.

The University of Pretoria Pre-University Academy (UP-PUA)

- University of Pretoria Pre-University Academy (UP-PUA) established for GR 8-12 learners from all quintiles

Aim

- promoting access and success into tertiary institutions.
  - ➢Access – low performers
  - ➢Success – high achievers (learners like Paul)

Objective

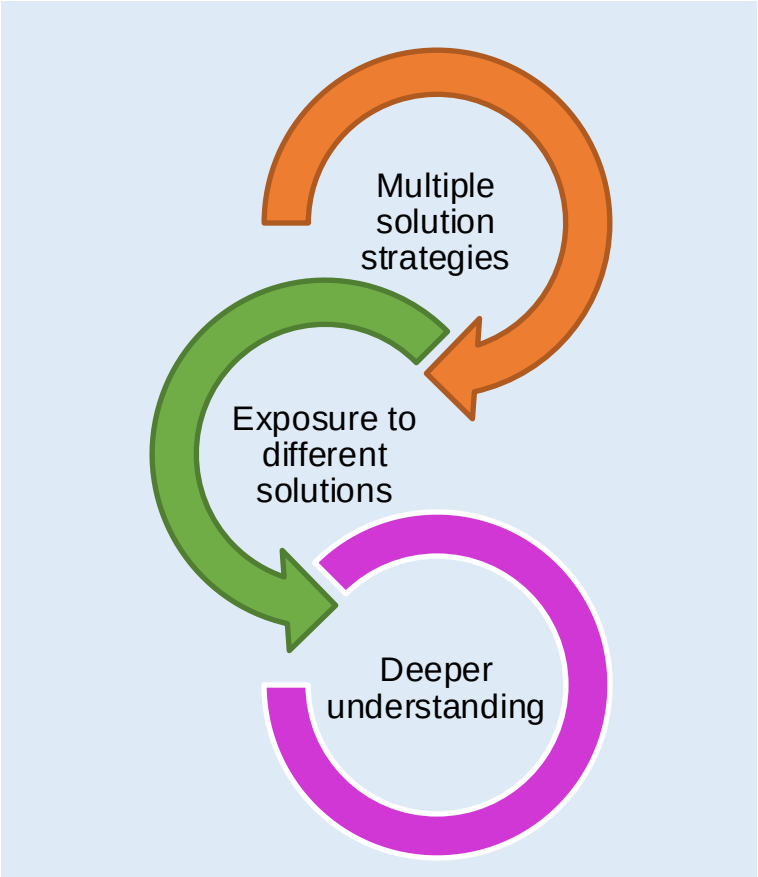
- deeper understanding
  - ➢mathematics
  - ➢physical science

Focus

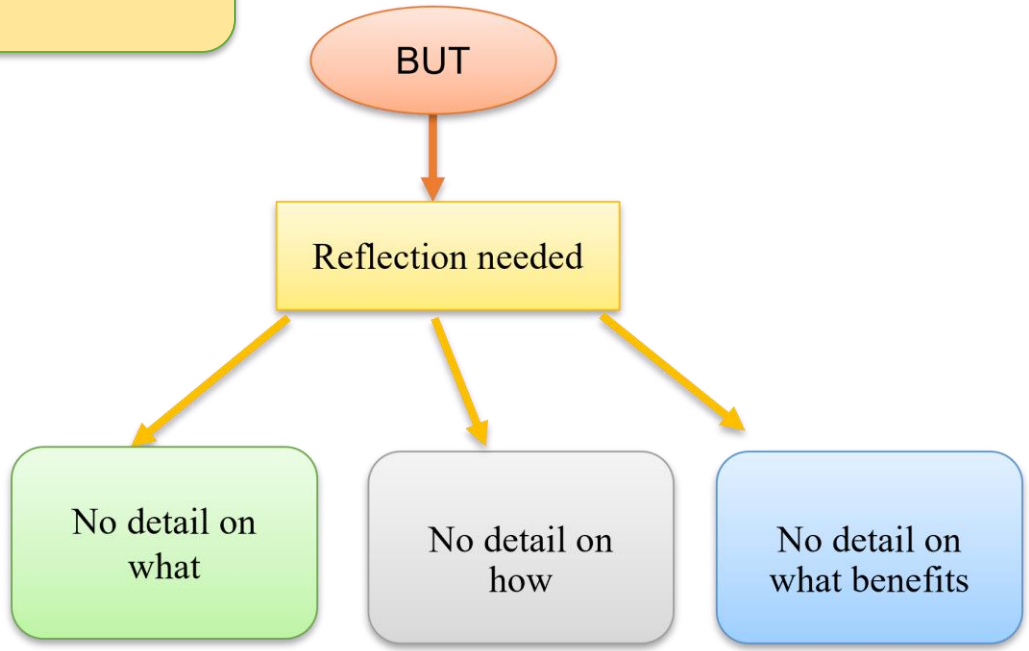
- Learners central
- Explain their thinking
- A focus on "why"

Focus of Study

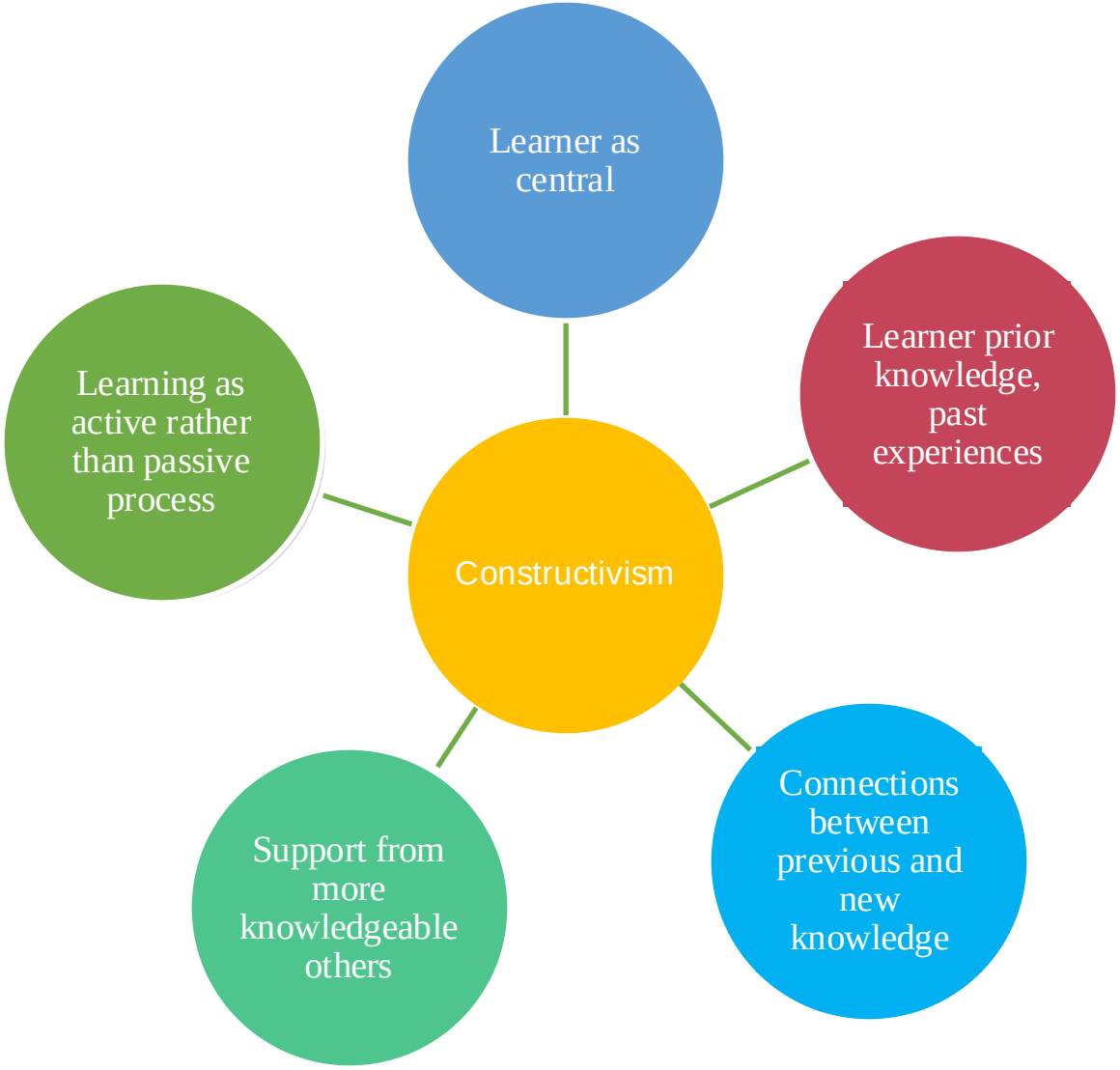
How do learners' explanations of multiple mathematical solutions contribute to a deep understanding of mathematical concepts?



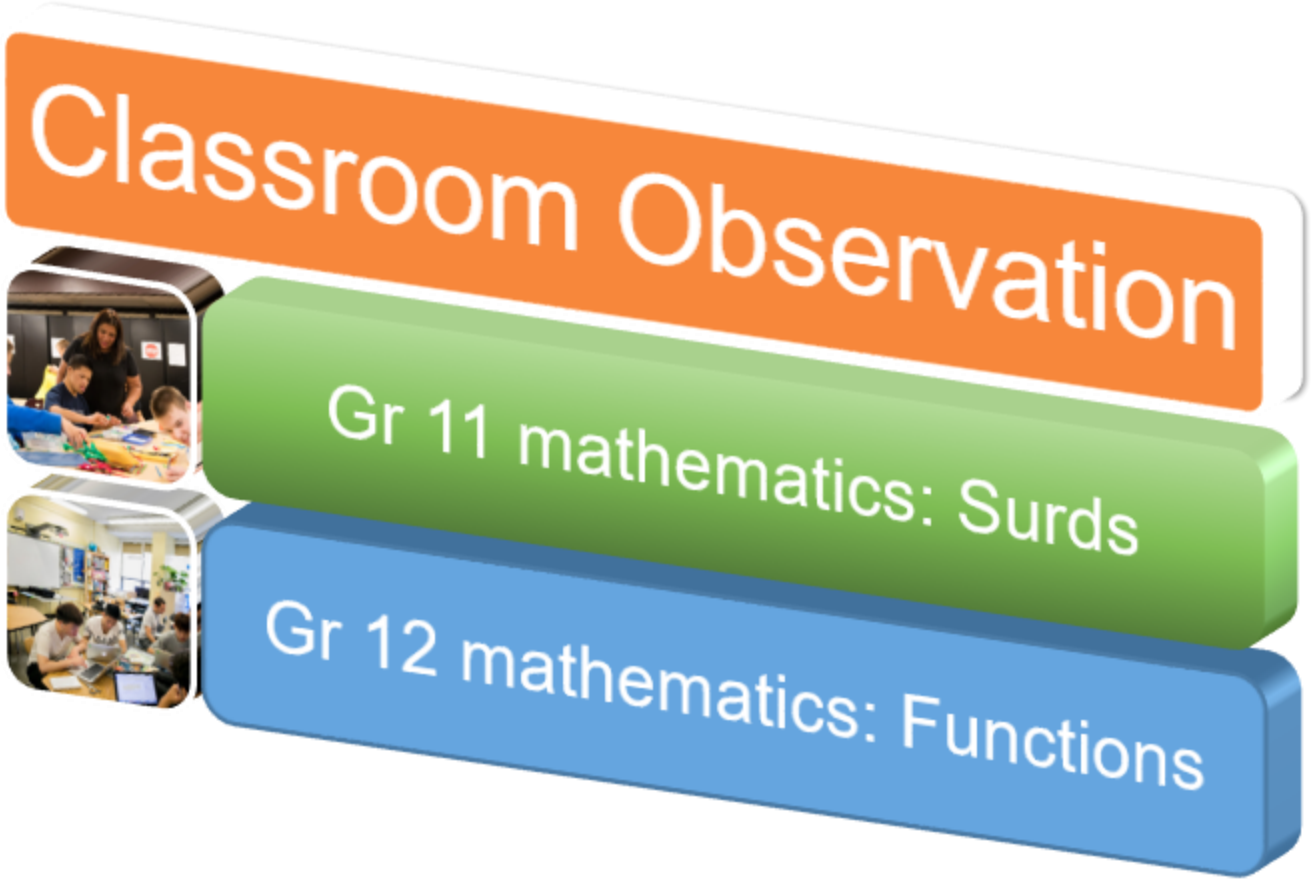
(Große and Renkl 2006)



Theoretical Framing



Data Collection Methods and Methodology

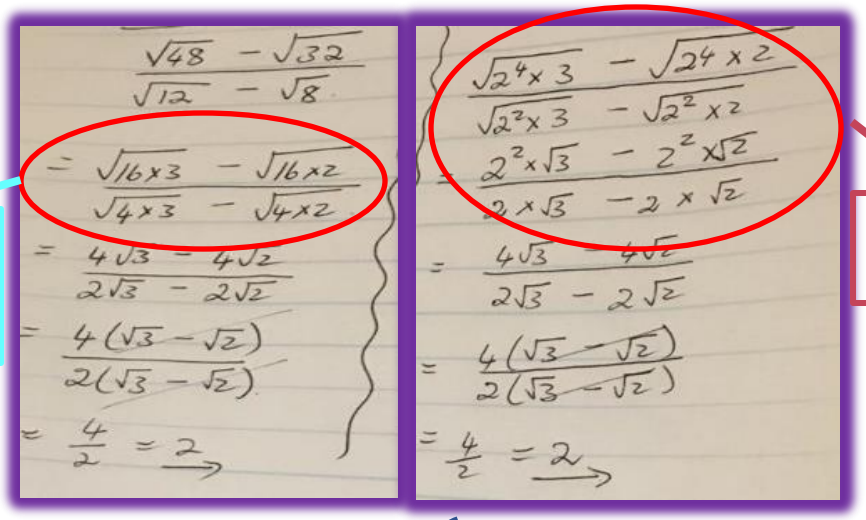


UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Fakulteit Opvoedkunde
Lefapha la Thuto

Gr 11 lesson

- Question: Simplify $\frac{\sqrt{48}-\sqrt{32}}{\sqrt{12}-\sqrt{8}}$ given to learners
- Groups of five learners.
- Solutions on mini-whiteboards
- Passed solution to person on their right who marked it.
- Learner with different solution to others in the group asked which method he preferred and why
- Learner asked to explain to class why he thought his solution was more efficient.



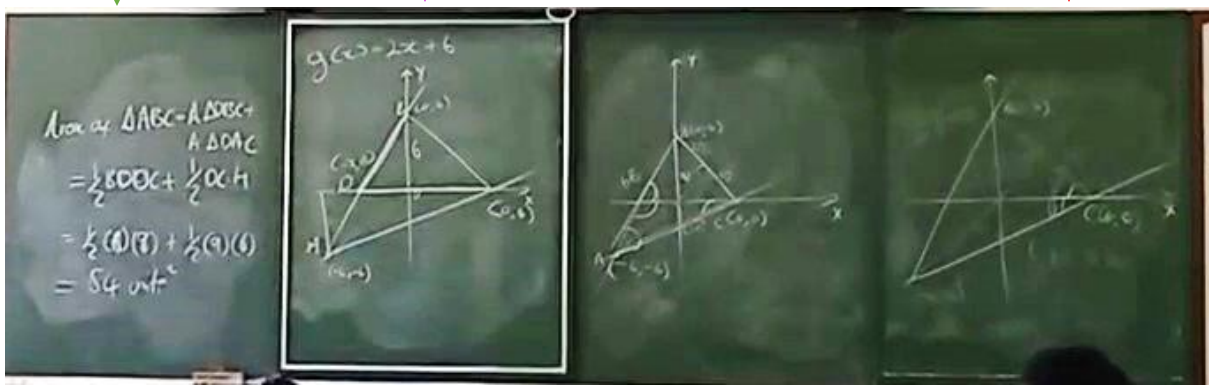
Results:

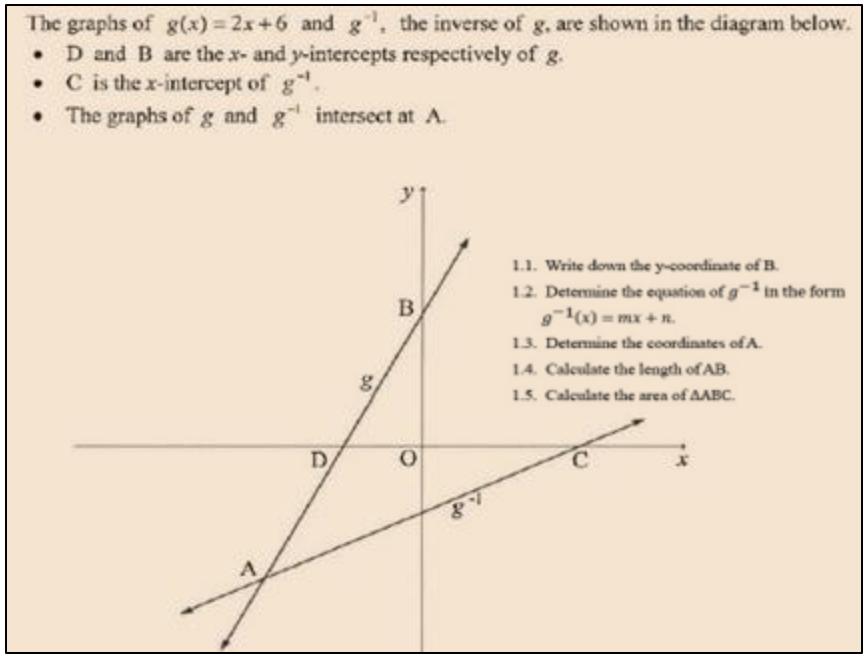
Type of Reflection	Description	Benefits
Self-reflection	Worked on own and passed to others in group	Preferred method based on what each learner best understood e.g. efficiency vs understanding
Group reflection	Discussion in groups about their different solutions	
Whole class reflection	Whole class discussion	

Gr 12 lesson

- Learners worked in 4 groups on question 1.5.
- Teacher asked a representative from each group to share solutions on the chalkboard.
- 3 learners and 1 tutor explained their different solutions on chalkboard.

Area = $\frac{1}{2}b \times h$ | Trigonometry | Algebra | Analytical geometry





Functions question

Results

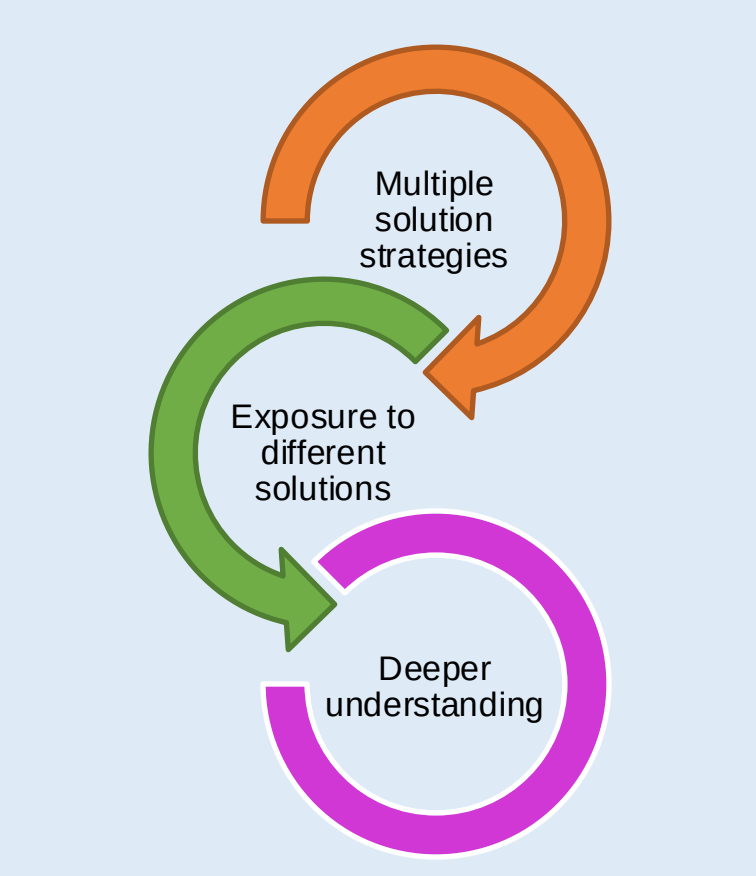
Type of Reflection	Description	Benefits
Group reflection	Discussion in groups about their different solutions	Connections between different mathematical concepts
Whole class reflection	Whole class discussion	

Discussion of Results

Methods used	• Gr 11: initially worked on own then with groups • Gr 12: in groups
Reflection	• self • within group • whole class
Benefits	• Advantages of strategies based on what is valued and context • Connecting of different mathematical ideas

Discussion of Results

How do learners' explanations of multiple mathematical solutions contribute to a deep understanding of mathematical concepts?



Learners individually and in groups provided different solutions

Learners listened to explanations of others on each solution strategy

Learners collaborated with those from different schools with different knowledge bases thus deepening understanding.

Implications of Results

Rethink teaching Style in classroom

- Change from chalk and talk in classrooms
- Results to be used in devising Professional development course for teachers

Math success at university

- Deeper understanding may aid in success at tertiary institutions
- All 54 of gr 12 learners qualify to enter university next year

Interventions in other universities

- Continued evaluation of our programme
- Develop a framework for a UP-PUA

THANK YOU

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education
Fakulteit Opvoedkunde
Lefapha la Thuto

Make today matter

www.up.ac.za