

Enhancing Conceptual Understanding of Fractions with New Methodological Tools (MERLO)



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- Full Professor at the University of Pretoria, Department of Early Childhood Education, University of Pretoria, South Africa.
- Doctoral degree in Mathematical Statistics from the University of Pretoria
- Serves on the editorial advisory board of *Scientific Studies and Research, Series Mathematics and Informatics*.
- Published over 120 articles in peer-reviewed journals
- Regularly present my findings at national and international conferences.
- Supervised over 20 Doctoral and over 30 Masters' students.



Introduction

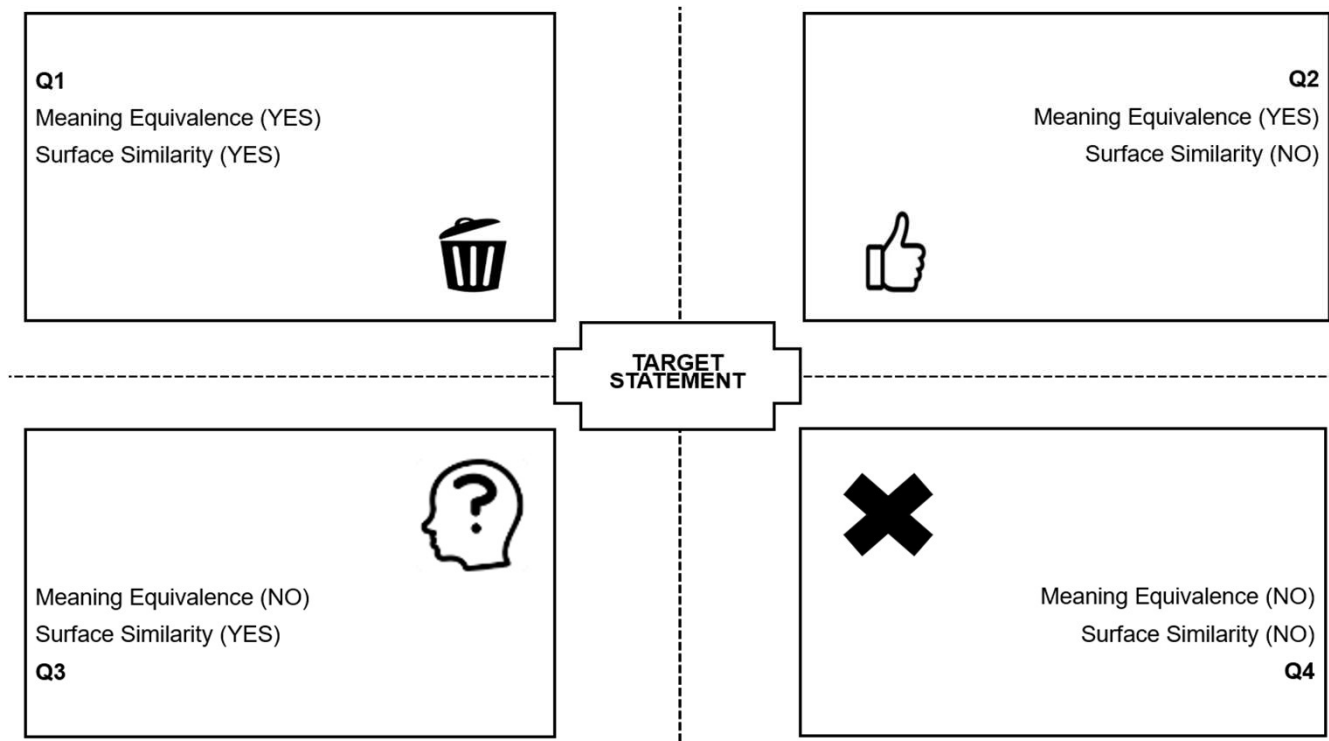
- The results of the TIMSS 2019 report highlight the distressing performance of senior phase learners in mathematics in South Africa, giving rise to significant concerns (Reddy et al., 2020).
- Low (< 400), middle (400-475), high (475-550), and advanced (550-625) criteria comprise what is referred to as the TIMSS benchmarks and learners that perform above the low benchmark are described as having acquired basic mathematical knowledge which is the case for **only 41%** of South African learners.
- In light of the substantial evidence revealing poor mathematics achievement within a South African context, as evidenced by the TIMSS 2019 results, it becomes imperative to enhance the effectiveness and efficiency of teaching, learning, and assessment practices.
- The successful implementation of effective teaching strategies within the classroom stands as a critical objective for both teachers and educational researchers.

Fractions

- Literature asserted that fractions form an integral part of basic knowledge for improving learners' mathematical fractional reasoning skills, specifically by the notion of replication of fractions (Hilton et al., 2016; Tzur, 2016)
- However, emerging a rigorous understanding of fractional knowledge is identified to be an issue (Tzur, 2016)

MERLO Item Framework

- Meaning equivalence is a concept that represents shared meaning across different forms of representations.
- Meaning equivalence reusable learning objects (MERLO) artefacts are a new type of didactical tool that can be framed by teachers and utilised in the classroom to engage learners in rigorous mathematical reasoning, discovery, and discussion.
- MERLO items require teachers to categorise and map significant concepts using sample target statements from certain conceptual contexts and relevant phrases that may or may not share the same meaning equivalence.




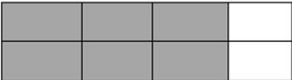
Significance of study

MERLO has evolved and has been validated, tested and implemented across different countries (Australia, Canada, Israel, Italy, Russia and the Netherlands) and across various content areas and disciplines, but not yet in African countries until this study.

Research Methodology

Topic	Used in current study
Theoretical framework	Theory of Didactic Transposition
Paradigm	Interpretative model of teachers' praxeologies
Research method	Qualitative Participatory Action Research (PAR)
Research design	Exploratory in nature
Participants	Two researchers and five senior phase South African mathematics teachers (90 learners) were selected conveniently and purposively
Data gathering	MERLO template and hand-out, field-notes observation, reflective writing, learners' workbooks, exit tickets, focus group discussions
Data analysis	Thematic Analyses

Examples of MERLO item on Fraction

Instructions	TS	Q2
<ol style="list-style-type: none"> 1. Mark all statements with the same mathematical meaning 2. Write down the thoughts that guided your decisions 	<p>A [] Fraction</p> $\frac{1}{2}$	<p>B [] Shapes</p> 
Q2	Q3	Q4
<p>C [] Decimal</p> 0.5	<p>D [] Fraction</p> $\frac{2}{5}$	<p>E [] Shapes</p> 

Note: Self-developed figure

Focus group discussion transcriptions

“I have learned how to convert and solve a fraction in different equivalent of representing an object in decimal and percentage”

“I have learned and understand how to change a fraction to fraction of a shaded shape that shared the same mathematical equivalence meaning”

Learners' workbooks

Class Activity MERLO

Fractions	TS	Q2A ✓
1. Mark the Statement (two or more) that Share the Same mathematical meaning. 2. Write the reasons for choice.	$\frac{3}{4}$	
	$\frac{3}{6}$ 9	

Reason: (A) - Q2A has the same meaning as $\frac{3}{4}$ (yes)
- Q2B has the same meaning as $\frac{3}{4}$ (yes)

MERLO

Fractions	TS	Q2A ✓
1. Mark the Statement (two or more) that Share the Same mathematical meaning. 2. Write the reasons for choice.		$\frac{5}{8}$
$0,625$		

MERLO Activities

Fractions	TS	Q2A ✓
1. Mark the statements (two or more) that Share the Same mathematical meaning. 2. Write the reasons that guided you in your choice.		
$\frac{2}{6}$	Q_3	Q_4
		60%

Reasons: B - Q2A has the same meaning as ~~$\frac{1}{3}$~~ $\frac{5}{18}$
~~Q2B has the same meaning as $\frac{1}{3}$~~
 Q2B has the same meaning as $\frac{5}{18}$

Reasons: C - Q2A has the same meaning as $\frac{1}{3}$
 Q2B has the same meaning as $\frac{1}{3}$

Exit tickets

EXIT TICKET TEMPLATE FOR LEARNERS AFTER IMPLEMENTATION

The purpose of exit ticket is to find out whether the lesson given to the learners have been achieved and understood. The exit ticket is a way of cross checking whether learners understood the subject been taught by the teacher which help them to adjust in their teaching in order to meet the need of their learners. This ticket is to reflect on what learners understood during teaching.

Exit ticket

Name: _____ Date: 26 August 2020
Subjects: Mathematics Grades: 9

Questions

Exit Ticket	1. Write out three new things you have learnt today? Three things I've learnt today - Surface Similarities. - Same meanings of fractions. - And also the summary of quadrants.
Exit Ticket	2. Write out two things you still don't understand which requires you to seek help.
Exit Ticket	3. Write out things you would like to learn more about. I would like to learn more about merlo ate or other target statement.

Discussion and Conclusion

- The implementation of MERLO pedagogy is very different from the usual classroom scenario where learners are given an exercise and are asked to solve the problem individually.
- The MERLO assessment is designed to allow learners to engage in discussion and exchange ideas related to a specific MERLO item.
- This process includes sharing and contrasting different points of view, prompting and refreshing each other's memory regarding important details of the conceptual situation, and comparing learners' notes about their practicable responses.
- However, there were some challenges, e.g., one of the teachers mentioned that:
“Hum, following a proper step, it was a bit difficult because sometimes, you know, the order can easily be forgotten. So, there is a specific order to follow when doing the presentations, but I used my workshop guide to remind myself”

Recommendations for future research

- Due to COVID-19, the study had a limited sample size of five teachers, suggesting the need for future research with more participants.
- The study recommends providing intensive professional training on the MERLO approach to teachers in different countries. Additionally, future studies aim to develop an online professional development course in MERLO to reach a wider audience of South African teachers.
- Introduction of MERLO to other African countries.

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MERLO publication by Prof Graham and Prof Graham's doctoral student

Adesanya, L. O., & Graham, M. A. (2023). Promoting formative assessment practices in senior phase mathematics classrooms using meaning equivalence reusable learning objects. *South African Journal of Education*, 43(3), Article 2245, 1-21. <https://doi.org/10.15700/saje.v43n3a2245>

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Promoting formative assessment practices in senior phase mathematics classrooms using meaning equivalence reusable learning objects

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MERLO publication by Prof Graham and Prof Graham's doctoral student

Graham, MA & Adesanya, LO. (2023). "Teacher professional development for the teaching of mathematics: MERLO items design in the South African schools". In Conference Proceedings: 13th International Conference the Future of Education (pp. 106-110). Filodiritto Editore.

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Teacher Professional Development for the Teaching of Mathematics: MERLO Items Design in the South African Schools

Marien Alet Graham¹, Lydia Omowunmi Adesanya²

MERLO publication by Prof Graham and Prof Graham's doctoral student

Adesanya, L. O., & Graham, M. A. (2022). Effective communication of learning intentions and success criteria in the mathematics classroom: MERLO pedagogy for senior phase South African schools. *Pythagoras*, 43(1), Article a666, 1-13. <https://doi.org/10.4102/pythagoras.v43i1.666>

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Effective communication of learning intentions and success criteria in the mathematics classroom: MERLO pedagogy for Senior Phase South African schools



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A well-designed assessment construct is critical for improving all aspects of quality education and validating the achievement of educational reform. The global prevalence of how teachers communicate learning intentions (LIs) and success criteria (SC) has been of great concern,

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Questions

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