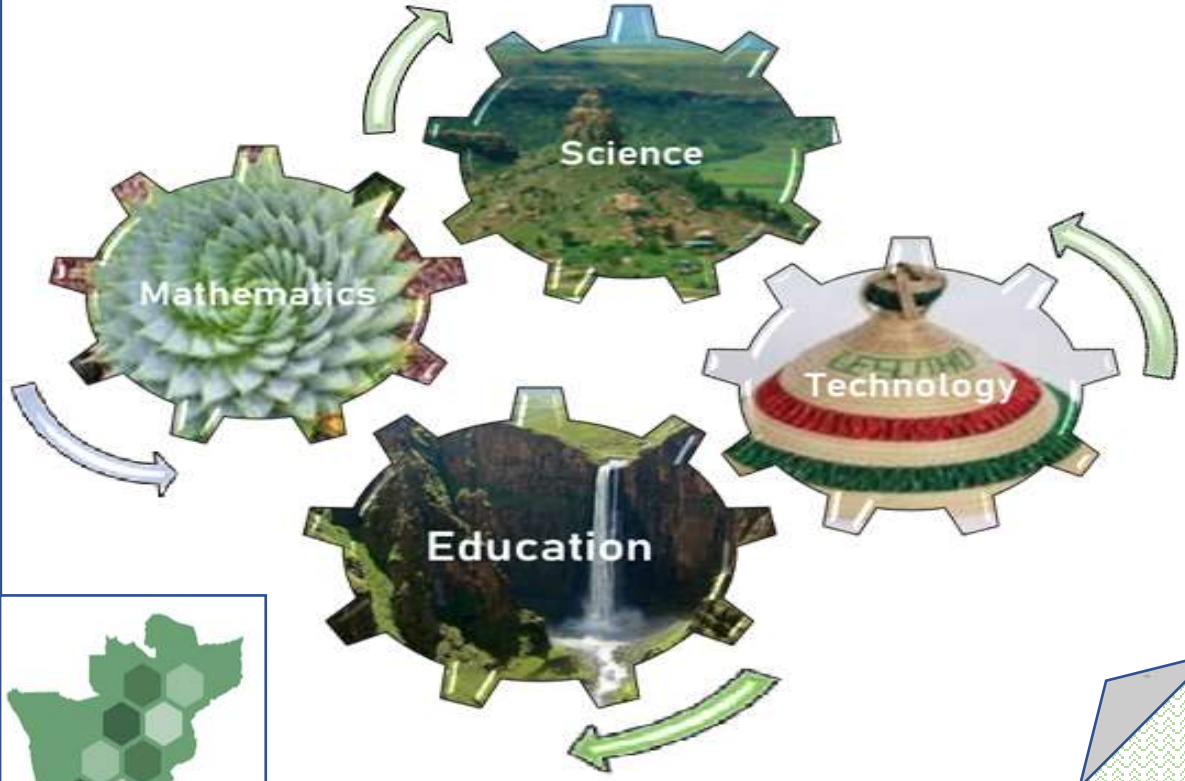
The 29th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education



12-15 January 2021

Conference Theme: Positioning and disrupting Mathematics, Science and Technology Education (MSTE) in the development agenda in Southern Africa.

PROGRAMME

NETE KE THEBE
NATIONAL UNIVERSITY OF LESOTHO

SAARMSTE 2021 is
hosted virtually
by
SAARMSTE-Lesotho Chapter
And
National University of Lesotho (NUL)

SPONSORS

The SAARMSTE Executive Committee would like to thank the following sponsors for their support of SAARMSTE activities. The sponsors make it possible for SAARMSTE to sustain the development of mathematics, science and technology researchers in southern Africa.

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MESSAGE FROM SAARMSTE PRESIDENT

It is my pleasure to welcome everyone to the SAARMSTE Conference, hosted by a collaboration between the SAARMSTE Lesotho chapter and the University of Lesotho, and to be held between 12th- 14th January 2020. While all SAARMSTE Conferences are special and dear to our hearts, this conference is special as our first virtual conference, running in the wake of a pandemic that has impacted the day-to-day lives of people across the planet, and left many dealing with loss and isolation. It has also affected the access to schooling for millions of children across the Southern African region and in many other parts of the world, exacerbating already wide inequalities. Planning for a virtual conference has meant new learning for all of us, with some variations in our traditional formats as we try and create an experience that will allow us to come together around issues in Mathematics, Science and Technology Education that are now more urgent than ever to address.

We think we have put together an exciting programme in a format that is aimed at interaction around papers, in topic-based sessions, led by expert regional and international co-Chairs. Many of these co-Chairs are long-standing 'friends of SAARMSTE' – experts who have attended previous SAARMSTE Conferences, partnered with researchers in our region and acted as facilitators at Research Schools. We also have two exciting plenary presentations linked to the Conference theme of 'Positioning and disrupting Mathematics, Science and Technology Education in the development agenda in Southern Africa'. Professor Vijay Reddy from the South African Human and Social Research Council will share her work on the TIMSS 2019 Mathematics and Science outcomes; Professors Julie Sarama and Doug Clements from the University of Denver will share insights on interventions to improve early mathematics outcomes based on their work on learning trajectories.

My thanks to the SAARMSTE Lesotho chapter and the University of Lesotho LOC team who have voluntarily given their time and expertise to work on the review process and the Proceedings. We would have loved to thank you in person in Lesotho, but – for now – this cannot be. Thanks also to all the session co-Chairs for honouring our conference with your knowledge and expertise. It is wonderful for all of us as paper and poster authors to have such eminent people in the field reading and leading discussion on our submissions. My work is within a generous and skilled SAARMSTE Executive who freely give their time and expertise to ensuring the smooth running of this organization – my thanks to them too.

To all attending the virtual SAARMSTE Conference, we are looking forward to watching your presentations before the event, and discussing your work. Thanks for your ongoing support of SAARMSTE. We hope to sing a little and dance a little together (virtually) for this year, and perhaps, raise a glass to the prospect of meeting face to face again in 2022.

Enjoy the Conference!

Hamsa Venkat

SAARMSTE President

EXECUTIVE COMMITTEE MEMBERS 2020/2021

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PLEANARY SPEAKERS

Julie Sarama and Douglas H Clements

Title: **Learning Trajectories as Disruptors of Early Math**

Short Abstract

Learn about five surprising research findings about early mathematics, including children's math potential, educators understanding of that potential, the need for interventions, and what we know about effective interventions using research-based learning trajectories. Learning trajectories can help disrupt some traditional approaches and provide research-based alternatives.

Bio

Julie *Sarama* is the Kennedy Endowed Chair in Innovative Learning Technologies and Distinguished University Professor at the University of Denver. She conducts research on young children's development of mathematical concepts and competencies, implementation and scale-up of curricula, professional development models and their influence on student learning, and implementation and effects of learning technologies (including those she has created). She has published 77 refereed articles, 6 books, 55 chapters, and over 80 additional publications. She has directed over 25 projects funded by the National Science Foundation (NSF), the Institute of Education Sciences (IES) and the National Institute of Health (NIH), the Bill and Melinda Gates Foundation and the Heising-Simons Foundation. She is currently conducting research on learning trajectories and developing tools and activities for teachers and caregivers who want to implement learning trajectories in early mathematics.

Douglas H. Clements, formerly a preschool and kindergarten teacher, is Distinguished University Professor, Kennedy Endowed Chair in Early Childhood Learning, and Executive Director of the Marsico Institute for Early Learning at the University of Denver. A major scholar in the field of early childhood math education and educational technology, with relevance to the academy, classroom, and policy, he has published over 166 refereed research studies, 27 books, 100 chapters, and 300 additional works , and has directed more than 38 funded projects, including the development of math curricula, software, teaching approaches, teacher training initiatives, and models of scaling up interventions. He has served on the U.S. President's National Mathematics Advisory Panel, the Common Core State Standards committee, and the National Research Council's Committee on Early Mathematics, and is and co-author of their reports.

du.academia.edu/DouglasClements, www.researchgate.net/profile/Douglas_Clements/

Dr Vijay Reddy

Dr Vijay Reddy is a Distinguished Research Specialist at the Human Sciences Research Council (HSRC). Dr Reddy assumed this position after serving as an Executive Director for 12 years (2006 to 2018). The three major thrusts of her research are large scale achievement studies, skills planning and public understanding of science.

Vijay holds undergraduate degrees from the University of KwaZulu Natal (previously University of Durban-Westville), a Masters from Rutgers University, USA (as a Fulbright Scholar), a Doctorate from the University of Durban-Westville (with joint supervision from University of Sussex). The dissertation, completed in 2000, was entitled: *Life Histories of Black South African Scientist: Academic Success in an Unequal Society*.

Vijay worked as a high school science and mathematics teacher, in science teacher development non-governmental organisations, university chemistry and science education lecturer and as a researcher. She is the South African National Research Co-ordinator for the Trends in International Mathematics and Science Study and has published extensively on TIMSS. Her recent publication, *Making global research locally meaningful* best reflects her stance related to international achievement studies.

MESSAGE FROM CHAIR SAARMSTE-LESOTHO CHAPTER

In wishing you a successful SAARMSTE 2021 virtual conference allow me to make the following remarks. This is the second time SAARMSTE - Lesotho Chapter and the National University of Lesotho host SAARMSTE conference. The first was in 2008 and one still remember how successful it was. This year we are hosting a special one; first SAARMSTE virtual conference. When COVID19 attacked the world last year, 2020, the LOC saw that as an opportunity to demonstrate SAARMSTE community's commitment to hosting successful annual conference. I see this year virtual conference therefore as a demonstration of this commitment. No disaster or pandemic can be allowed to stand on our way. But it is true though that COVID – 19 managed to deny members of SAARMSTE a visit to the Mountain Kingdom.

The theme of this virtual conference is ***Positioning and disrupting STEM in the development agenda in Southern Africa***. The interest of LOC, when deciding on this theme, was a call to members of SAARMSTE, and interested scholars, to demonstrate through research what could be done to respond to glaring need for new innovative curriculum developments that addresses challenges of MSTE today. This need has been demonstrated by COVID19 pandemic and the human loss many countries have suffered. We are happy to see that many presenters addressed this theme and further want to call on members to continue, after this virtual conference, to think of possible innovations. Southern Africa, and indeed the world, urgently needs new curriculum innovations.

There are 117 papers accepted for this virtual conference. Few than ten presenters declined or failed to upload their presentations on time. This is a decline from last year numbers but a big demonstration of commitment by SAARMSTE members and international scholars. Congratulations!!

Lastly, I wish to thank all reviewers, editors, presenters and chairs of the sections for their hard work in contributing to the success of this virtual conference. It would be remiss of me not to thank the LOC and the Executive Committee for the time and their finances they used to organise this virtual conference. Special vote of thanks to all sponsors for the they continued to give to SAARMSTE.

I wish you successful thought-provoking debates!!

GUIDELINES FOR PAPER SUBMISSION AND PRESENTATION

Long paper: Maximum of 6000 words, including references, for a 30-minute pre-recorded, narrated presentation. Long papers are equivalent to journal publications utilising the same criteria as AJRMSTE articles and are reviewed accordingly. In accepting a long paper for presentation at the SAARMSTE conference, the Review Panel presumes:

1) The paper is original and has not been published elsewhere;
2) Permission will be granted by the author for the accepted long paper to be published in the accredited *Book of Proceedings*;
3) At least one of the authors will register and attend the conference to present the paper;
4) First authors will only present one long paper at each conference.

Long papers are fully peer reviewed and thus attract Department of Higher Education and Training subsidy.

Short paper: Maximum of 1500 words, including references, for a 20-minute pre-recorded and narrated presentation. Short papers should highlight preliminary findings and significance of the research. Short paper submissions could be the first draft of a journal article consisting of: abstract, introduction literature review, methodology, results and conclusions. Authors are encouraged to submit short papers for development of an article at the post conference workshop. After acceptance of the 1500 word short paper, authors may elect to develop their research further into a 3600 word paper which will NOT be reviewed but, after consultation with the editor, could appear in the electronic record of Research Papers in Mathematics, Science and Technology Education. Short papers are **not** eligible for DHET subsidy.

Snapshot paper: Maximum of 1500 words, including references, for a 10-minute pre-recorded and narrated presentation. Snapshot papers should be based on emerging research, not necessarily with results, but with a framework of: abstract, introduction, literature review, methodology and the way forward.

Guided poster: Maximum of 1500 words, including references, for a 10-minute pre-recorded poster with some narrated, descriptive text. An outline of the main features of the author's research which will be reported on in the content of the poster presentation.

Symposium / panel paper: Maximum of 1500 words, including references, for a 90-minute pre-recorded and narrated team discussion around issues where different points of view, approaches, debates or analysis of the same problem are presented. The paper should contain details of each speaker's contribution and how these come together to create a forum for debate. This is not a forum for the presentation of multiple short papers. The emphasis is on exchange of ideas and discussion.

Short papers, snapshots, posters and symposia papers should appear in the 2021 electronic record of Research Papers in Mathematics, Science and Technology Education. These are not fully peer reviewed and thus do not attract Department of Higher Education and Training subsidy.

REVIEWING PROCESS FOR SAARMSTE LONG PAPERS 2021

All 6 000 – word long papers were reviewed by at least two external reviewers.

Reviewers were selected from the list of reviewers for the African Journal for Research in Mathematics, Science and Technology Education (AJRMSTE) published by Taylor & Francis. Other recognized researchers in the field of Mathematics, Science and Technology Education were also approached to be reviewers.

The reviewers' suggestions were considered by the members of the Review Panel. Where there was consensus, the reviewers' recommendations were accepted by the Review Panel. Where consensus was not reached, the Review Panel appointed at least one other reviewer and all reviews were taken into consideration before a decision was made.

In cases where papers were accepted with conditions, authors were guided to make changes in order to have their papers accepted, or provide a compelling argument for no further revision.

Long papers that were re-worked and re-submitted by authors underwent a final review and editing process before being published in the accredited Book of Proceedings.

SAARMSTE LONG PAPER REVIEWERS 2021

The SAARMSTE 2021 conference organising committee thanks the following long paper reviewers for their time and expertise:

Lawan	Abdulhamid
Jogymol	Alex
Mike	Askew
Patrick	Bamby
Martin	Braund
Bruce	Brown
Million	Chauraya
Kensuke	Chikamori
Clemence	Chikiwa
Daniel	da Costa
Bette	Davidowitz
Helen	Drummond
Washington	Dudu
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Hileni	Kapenda
Mercy	Kazima
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Corin	Mathews
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Eunice	Nyamupangedengu
Femi	Otulaja
Craig	Pournara
Nicky	Roberts
Sally-Ann	Robertson
Marissa	Rollnick
Marc	Schafer

LONG PAPER REVIEWERS 2021 CONTINUED

Ingrid	Schudel
Doras	Sibanda
Clement	Simuja
Asheena	Singh-Pillay
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Sonja	Van Putten
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Roy	Venketsamy
Lyn	Webb
Lise	Westaway

SAARMSTE

Southern African Association for Research in Mathematics, Science and Technology Education

2021 CONFERENCE PROGRAMME

SAARMSTE Conference 2021 – Programme:		
Tuesday 12th January 2021 Time: 09h10 – 10h30		
	Mathematics by Theme	**Science by Theme**
Theme:	**EARLY GRADE MATHS TEACHING AND LEARNING**	***INDIGENOUS SCIENCE KNOWLEDGE***
Chairs:	*Mellony Graven & Hamsa Venkat*	Emmanuel Mushayikwa & Emilia Afonso Nhalevilo
Papers:	**Liveness Mwale,** An exploration of the teaching of capacity in Grade 4 in Malawi LP-M045	**Bhamini K Applasawmy, M Rollnick & E Nyamupangedengu** Using Personal Meaning Maps to assess the informal learning of biodiversity SP-S011
	Nicky Roberts & Q Moloi Impact on mathematics learning outcomes: A cross-sectional quasi experiment using the Early Grade Mathematics Assessment (EGMA) LP-M054	**Mercy Nyamekye & S Danso** The use of Padlet tool to improve learning outcomes among secondary school biology learners: an experimental study towards a shift in pedagogy. SN-S001
	Mellony Graven A family focused story-based approach to strengthening early numeracy SP-M008	
	Roy Venkatsamy & S Mamogale Exploring challenges experienced by teachers teaching number sense in the foundation phase LP-M011	
	Pamela Vale The influence of length measurement estimation activities on Grade 3 learners' number line estimation SP-M032	
	Kitso Maragelo Subitising: a under-utilised mathematics construct in preschool mathematics teaching and learning SP-M046	
TAKE A BREAK – Coffee / Tea		
Time: 11h00 – 12h30		
Theme:	**MATHEMATICAL PS & EXPLANATION**	**SCHOOL SCIENCE TEACHING**
Chairs:	Sharon McAuliffe & Patrick Barmby	Fred Lubben, Marietjie Potgieter
Papers:	**Vasantha Moodley, C Pournara & M Askew** Mathematical Instructional explanations with a spatial component LP-M024	**Sakyiwaa Danso** Physical sciences learners' and teachers' perceptions of learning style-based instructional strategies LP-S024
	Bruce Brown Module and Assessment Design to Develop the Mathematical Thinking of Preservice Primary School Education Students	**Mmapaseka Stephen & E Mushayikwa** Improving teaching quality through Professional learning communities (PLC)

	LP-M029	SP=S056
	Lisnet Mwadzaangati & M Kazima Self-regulation strategies used by female student teachers in primary mathematics teacher education. LP-M016	**Bongeka Mabaso & S Ngema** Gazing into instructional practices of integrated natural science and technology teachers in the intermediate phase SN-S027
	Nontsikelelo Luxomo Form, structure and representations of algebraic expressions: what is the explanation? SP-M056	**Nadaraj Govender & P Mbono** Factors Influencing Agricultural Science Teachers' Confidence in Chemistry Teaching in Rural Schools – Time for Disruption SP-S003
		Nkhululeko Dlamini-Nxumalo, C Mandikonza & M Mosabala Science Education Lecturers' Practices in Preparing Science Student Teachers in Readiness for Competency Based Education: A Case of Eswatini Teacher Training Colleges SP-S018
		Lettah Sikhosana & A Mudau The development and implementation of the sustainable intervention strategies for solid waste management in primary schools: SN-S052
LUNCH TIME		
Time: 13h30 – 15h00		
	SYMPOSIUM 1	SYMPOSIUM 2
Chairs:		Marissa Rollnick
	THIS SYMPOSIUM HAS BEEN WITHDRAWN Sym-M040	**M. Rollnick, P.W. Hewson, M. Hewson, H. Venkatakrishnan, T. Morar, A. Msimanga, J.A. Luft; Z. Nhase; F. Lubben; P. Gates, E. Mavhunga, S. Mupfawa.** Reflection on an innovation: SAARMSTE' S 2020 virtual research school Sym-Mste001
Time: 15h30 – 17h00		
	PLENARY DISCUSSION	
Presenters:	**Doug Clements and Julie Sarama** **Learning Trajectories as Disruptors of Early Math**	
Discussant:	**Mike Askew**	
	Time: 17h00 – 17h30	
	OFFICIAL WELCOME TO SAARMSTE'S FIRST VIRTUAL CONFERENCE	

Wednesday 13th January 2021 Time: 09h10 – 10h30			
	Mathematics by Theme	**Science by Theme**	**Technology by Theme**
Theme:	***MULTIPLICATIVE WORKING***	**LANGUAGE IN SCIENCE**	
Chairs:	**Pamela Vale & Jana Visnovska**	Audrey Msimanga & Miranda Rocksen	
Papers:	**S Morrison** A multiplicative reasoning intervention in grade 2 LP-M051	**Nomzamo Xaba, E Nyamupangedengu & M Rollnick** An investigation of how biology lecturers in a south African teacher training program use language to engage pre-service teachers in the meaning making processes of their lessons SN-S019	
	J Longwe-Mandala Explanations about how to teach place value made available for student teachers to learn SP-M005	**Ndivhuwo Netshivhumbe & A Mudau** Developing the Tshivenda scientific register and its influence on the teaching and learning of physical sciences SN-S037	
	Fraser Gobede Affordances and constraints of using place-value boxes in the teaching of two-digit addition in Grade 2 SP'M006	**Thuli Ntuli & A Mudau** Developing the scientific language register for natural sciences in IsiNdebele and its application in some classes in the Siyabuswa 2 circuit. SN-S049	
	Satoshi Kusaka Analysis of the Teaching Content and Its Order with regard to Fractions in Three Eastern and Southern African Countries: Fundamental Study of Mathematics Curricula in African Countries to Achieve Goal 4 of the SDGs SN-M001	**VJ Ramashia & AV Mudau** Developing and application of a Xitsonga physical science scientific register for Xitsonga home language teachers and learners SN-S059	
	Jaqueline Luksmidas & C Pournara A discursive framework for percent SP-M017		
	Tarryn Lovemore Using music to teach fractions SN-M027		
	Demi Edwards An analysis of learning trajectories with rational numbers in South African textbooks SN-M035		
	Tammy Booysen The use of visual images in multiplication and division in three South African foundation phase mathematics texts		

	PO-M031		
TAKE A BREAK – Coffee / Tea			
Wednesday 13th January 2021 Time: 11h00 – 12h30			
Theme:	***TERTIARY TEACHING & LEARNING***	***PEDAGOGICAL CONTENT KNOWLEDGE***	***ICT & DISRUPTION***
Chairs:	Rina Durandt & Delia Marshall	**Marissa Rollnick & Vanessa Kind**	Kelly James Keevy, Reginald Govender & Busisiwe Alant
Papers:	**Gareth Braatvedt & R Durandt** A glimpse into the mathematical readiness of students undertaking a university third-year mathematics major LP-M022	**N Q Vokwana, E M Mavhunga & M Rollnick** Enacted Topic Specific Pedagogical Content Knowledge: a case of rural out of field Natural Sciences teachers in the Eastern Cape province of South Africa SP-S028	**Leila Goosen & D van Heerden** Students' perceptions of e-assessment in the context of COVID-19: the case of UNISA LP-S003
	Rina Durandt, W Blum & A Lindl Exploring first-year engineering student's prior knowledge in mathematics SN-M023	**M Tsakeni & C Makamure** The inquiry-based practical work pedagogical content knowledge of primary preservice teachers in Lesotho and Zimbabwe SP-S040	**Portia Kavia** Exploring the transition from blended teaching to emergency remote teaching in the wake of the Covid-19 pandemic: Teacher educators' experiences LP-S007
	Frikkie George & E Rzyankina Multimodal online teaching: Experience of engineering mathematics students SN-M049	**Bongani Ndlovu & E Mavhunga** Conceptualisation of content knowledge related to teaching school science: a systematic literature review SP-S042	
		Jeannette Muterampundu, T Nsengimana & V Nsengimana Perceived teachers' subject content and pedagogical knowledge of the inquiry and techniques used in teaching and learning of biology in Rwanda secondary schools SP-S062	
		William Veal Creativity and PCK in Elementary Preservice Teachers SN-S010	
LUNCH TIME			

Wednesday 13th January 2021 Time: 13h30 – 15h00			
Theme:	**LANGUAGE IN MATHS EDUCATION**	**ONLINE TEACHING & LEARNING**	
Chairs:	Tony Essien & Nuria Planas Raig	Washington Dudu, Paul Denley & Dorothy Nampota	
Papers:	**Sally-Ann Robertson & M Graven** Teacher Talk As 'Model' And 'Scaffolder' In Second Language Contexts of Mathematical Problem-Solving SP-M013	**M Braund** The COVID-19 Pandemic: Time for Critical STEM Literacy LP-S006	
	Ingrid Mostert & N Roberts What's in a name? Fraction naming conventions in isiXhosa SP-M019	**A C Novela & B Bernardo** Learning Evaluation on Covid-19 Pandemic Time. Biology Students' Reports from the Pedagogical University of Maputo SP-S012	
	Clemence Chikiwa & M Schäfer Teacher gestures and verbal language: an indispensable semiotic and symbiotic relationship in multilingual mathematics classes SP-M038	**M Kazeni** Targeted Web-Based Instruction: Effectiveness and gender parity in the study of Grade 4 Astronomy SP-S015	
	A Dlamini & E Henning Solving Word Problems in Grade 3: When Arithmetical Thinking and Reading Competence Collide SP-M047	**L Mohafa** Views and experiences of Lesotho Science Teachers in a virtual environment: Threats and opportunities SP-S054	
		T Rangoanana & T Mokuku Analysis of Lesotho Secondary Science teachers' self-efficacy in the use of digital audio-visuals in teaching SP-ST008	
		F Zondi Translation of science pre-service teachers' PCK from one PCK realm to another in an online teaching and learning environment SN-S014	
		T E Nkanyani & A Mudau Exploring challenges and opportunities of Physical science educators` use of Blended learning in a rural setting. SN-S044	
		O Sadare Exploring the challenges and opportunities in the teaching of physical sciences during the fourth industrial revolution SN-S057	

Wednesday 13th January 2021 Time: 13h30 – 15h00			
		A Buma & M Rollnick Technological adaptations shaping the enacted PCK of in-service science teachers: A blended learning approach SN-S058	
		L Pilcher Blending online homework and large class tutorials to provide learning support in introductory organic chemistry. SN-S008	
		L Rakhunwana Effective learning strategies for a first-year blended chemistry course SN-S009	
Wednesday 13th January 2021 Time: 15h30 – 17h00			
Theme:	**NOTICING & REFLECTING in/for INSTRUCTION**	***TOPIC SPECIFIC PEDAGOGICAL CONTENT KNOWLEDGE***	**ICT & BASIC EDUCATION**
Chairs:	Lawan Abdulhamid & David Wagner	*Elizabeth Mavhunga & Peter Hewson*	Craig Blewitt, Reginald Govender & Busisiwe Alant
Papers:	**Janne Fauskanger & R Bjuland** Learning to notice learners' mathematical thinking while co-enacting instruction LP-M003	**Elizabeth Mavhunga & J Miheso** Operationalizing the grand pck rubric: a case of developing a classroom rubric for portraying etspck LP-S033	**Angela Stott** Changes in IT and CAT enrolment and performance across South African school types LP-T002
	Samu Chikiwa & M Graven Pre-service teachers' levels of reflection on mathematics lessons: a review, and adaptation, of frameworks LP-M018	**Denise van der Merwe, E Mavhunga & M Rollnick** The conceptualization of digital-TSPCK SP-S034	**Bonnqe Toalane & T Jita** Collaborating on ICT integration in basic education. The case of a teacher in Lesotho SP-T006
	Lise Westaway & P Vale Preservice teachers' noticing of children's addition calculation strategies LP-M026	**Mamohato Makhechane & E Mavhunga** Exploring the development of the post-graduate pre-service teachers' planned topic specific PSK of chemical equilibrium SP-S035	
	Zanele Ngcobo, S Ngema, S Bansilal & T Mkhwanazi Reflecting or not reflecting: Secondary mathematics teachers' perspectives SP-M010	**Doras Sibanda& M Rollnick** Post graduate certificate in education students' topic specific pedagogical knowledge on particulate nature of matter SP-S039	
Time: 17h30 – 18h00			
SAARMSTE Annual General Meeting (AGM)			

Thursday 14th January 2021		
Time: 09h10 – 10h30		
	Mathematics by Theme	**Science by Theme**
Theme:	**SECONDARY MATHS TEACHING & LEARNING**	**PHYSICS AND CHEMISTRY TEACHING IN ITE**
Chair:	Craig Pournara & Merrilyn Goos	Judith Bennett & Makomosela Qhobela
Paper:	**Yvonne Sanders, C Pournara & C Dampier** A case study on responses to integer items: a change in errors from grade 9 to grade 10 LP-M021	**C Mundy** The value of integrating the UN Sustainable Development Goals with a microscale experiment for chemistry students LP-S041
	Wellington Hokonya, P Vale & M Graven An exploration of a South African high school learner's narrative mathematics learner identity SP-M012	**M Potgieter** Development of a "Systems Thinking" component for first year organic chemistry SP-S002
	Sikeme Raphoka & B Mofolo-Mbokane Developing Learner-Autonomous Mathematics Learning Environment (LAMLE) Model: A Framework for curriculum implementation in Lesotho SP-M033	**R Khan** Successes, challenges and opportunities: An investigation of a teacher educator's pedagogy of integrating the teaching of methodology and content when teaching meiosis to fourth year pre-service teachers SP-S021
	Bernard John Ssennyomo & C Chikiwa Visual teaching of word problems for conceptual understanding in grade 9 SP-M037	**C Khoza** Exploring teacher talk moves in science lessons SP-S025
	Craig Pournara Poor mathematics performance in Grade 9 in South Africa: The curriculum may be part of the problem SN-M055	**B v d Westhuizen** Investigating the effectiveness of teaching methods used in teaching magnetism in a first year Bed SP/FET physical sciences course SN-S029
	Clemence Chikiwa Visualisation processes in the teaching of secondary school mathematics: experiences of PGCE pre-service teachers PO-M036	**S Khulu** From compliance to integration: Micro science enables learning through practical activities PO-S047
		A Stott The Efficacy of Use of the Unit Factor Method at a Professional Development Workshop to Promote Teachers' use of Proportion In Solving Reaction Based Stoichiometry Questions SP-S007

	Thursday 14th January 2021 Time: 11h00 – 12h30	
	PLENARY DISCUSSION	
Presenter:	**Vijay Reddy** MATHEMATICS AND SCIENCE ACHIEVEMENT AND ACHIEVEMENT GAPS IN SOUTH AFRICA	
Discussant:	MATHEMATICS: **Moneoang Leshota** SCIENCE: **Eunice Nyamupangadengu**	
	Lunch Time	
	Thursday 14th January 2021 Time: 13h30 – 15h00	
Theme:	**ASSESSMENT & LARGE-SCALE STUDIES**	**ASSESSMENT IN SCHOOL SCIENCE**
Chairs:	Nicky Roberts & Anil Kanjee	Doras Sibanda & Sibel Erduran
Papers:	**Justice Enu & Z Ngcobo** Alignment between mathematics teacher educators understanding of formative assessment and Ghana's policy on assessment LP-M007	**M Janefeke** Trends in academic performance of grade 12 students in LGCSE physical science from 2014 to 2018 SP-S016
	Patrick Barmby, C Foster, I Jones, J Kelly & J Milinkovic Using a comparative judgement approach to assess the problem-solving skills of primary school pupils SP-M004	**M Khoarai** The implementation of continuous assessment by one primary science teacher in Lesotho: A case study SP-S055
	Kgomotso G Garegae The relationship between reading and mathematics achievement levels in Botswana: An exploration of SEACMQ IV Study SP-M039	
	Sechaba Koma & S Raphoka Online Mathematics Teaching During Covid-19 Pandemic In Teacher-Training Institutions: A Question of Assessment and Interactive Discourse PO-M034	
	Thursday 14th January 2021 Time: 15h30 – 17h00	
Theme:	***TEACHER KNOWLEDGE & PRACTICE***	***SCHOOL SCIENCE LEARNING***
Chairs:	*Mercy Kazima & Arne Jakobsen*	*Angela James & Julie Luft*
Papers:	**Everton Jacinto** Teaching Multiplication Using Multiple Representations: What Works for Pre-Service Teachers in Malawi SP-M014	**Nellie Mbano & T Zolowere** How secondary students use self-regulation in learning biology LP-S043

	Kolace Silwimba & Arne Jakobsen Investigating How Teachers Introduce Algebra in Primary Schools in Malawi. A case Study of Three Teachers in Standard 5. SP-M030	**Francis Lenonya & T Mokuku** Investigating science students' water literacy in relation to a local stream: a case study of one high school in Leribe LP-S030
	Judah Makonye On models for teaching directed numbers SP-M050	**Shalini Dukhan** The impact of lockdown on authentic learning opportunities within laboratory-based disciplines, and the influence of this on the development of science identity SP-S022
	Odette Umugiraneza Examining teachers 'pedagogical content knowledge in teaching proportions tasks SP-M002	**Allie Osman & J Kriek** Perspectives of physics teachers on implementation of problem-based learning in high schools SP-S051
	Jayaluxmi Naidoo Disrupting Traditional Pedagogy: Exploring Students' Experiences of Online Pedagogy for Mathematics Education SP-M015	**Nomfundo Radebe & E Mushayikwa** Learner-learner talk: A teaching method to enhance learning of science SP-S053
	Albert Boateng-Ofosu & JK Alex Sharpening the focus on problem solving: exploring pre-service mathematics teachers pedagogical content knowledge and it use in classroom pedagogy PO-M028	**Ngonidzashe Mushaikwa & L Rusznyak** Knowledge-Building in the South African Primary Sciences Curriculum: knowledge about day/night causes SP-S060
	Thursday 14th January 2021 Time: 17h30 – 18h30	
	Awards/Choir/Gala Dinner/Dancing	

SAARMSTE 2021 ABSTRACTS

MATHEMATICS LONG PAPERS

A GLIMPSE INTO THE MATHEMATICAL READINESS OF STUDENTS UNDERTAKING A UNIVERSITY THIRD-YEAR MATHEMATICS MAJOR

Gareth Braatvedt & Rina Durandt
University of Johannesburg

Abstract

This paper reports on empirical results about the mathematical readiness of students undertaking a university third-year mathematics major. These students are expected to have a substantial level of mathematical background upon entering their third-year Real Analysis mathematics studies. By virtue of time constraints in this module, it is not always possible for the lecturer to comprehensively summarize knowledge that is considered prerequisite for the module. However, for students who are unable to recall this prerequisite knowledge or who have knowledge gaps in this regard, this can be a substantial stumbling block. A group of 81 students were exposed to a carefully planned diagnostic test focusing on the key knowledge components in the Real Analysis module. Descriptive statistics were used to analyse students' work. The results show potential stumbling blocks for students and, at the same time, develop possibilities for educators to remedy students' deficiencies and increase study success.

MODULE AND ASSESSMENT DESIGN TO DEVELOP THE MATHEMATICAL THINKING OF PRESERVICE PRIMARY SCHOOL EDUCATION STUDENTS

Bruce Brown
Rhodes University, South Africa

Abstract

This paper presents results from a design research study into the design of a conceptual framework, learning activities, assessment processes and teaching programmes for the development of mathematical thinking in preservice, Primary Education students. It reports on data from a particular implementation of this design - a module teaching fundamental mathematics to preservice, primary education students. The module aimed to generate a positive experience of mathematical thinking, to counter students' possible, past experience of mathematical learning that may have been rigid and formulaic. The module required students to engage with mathematical content in an extended way, emphasizing the importance of meaning making and reasons in mathematics. Three different response modes were included in tutorials and assessment: compact, visual and elaborated. The paper presents and compares summary results of an initial benchmark, a midyear and a final assessment, for each of the three response modes, as well as for three mathematical topic categories in the compact mode. The results show an appreciable and significant improvement in student performance in each of the three modes and for each of the three topic categories. This suggests that this design may prove effective for developing students' mathematical thinking.

PRE-SERVICE TEACHERS' LEVELS OF REFLECTION ON MATHEMATICS LESSONS: A REVIEW AND ADAPTATION OF FRAMEWORKS

Samukeliso Chikiwa & Mellony Graven
Rhodes University, South Africa

Abstract
Reflective practice is increasingly recognised as an important aspect for teacher professional development. Research on developing mathematics teachers' reflective practice through analysis of video recorded lessons is on the rise. Several frameworks have been developed by a range of researchers across contexts to establish the levels of reflection teachers engage in while developing reflective practice. In this paper we provide a brief review of the rationale for the importance of developing teacher reflection in the context of mathematics teachers and then focus our review on comparing various analytic frameworks for analysing teacher reflections according to a range of levels. We argue, based on the findings of the first author's doctoral research study that mathematics teachers' reflection in the South African context requires some adaptation to these analytic frames. While this is primarily a review paper from which we propose an adapted analytic frame tailored to the South African context, we provide some exemplar pre-service teacher reflections to illustrate the nature of teacher reflections that led to the adaptation of existing frameworks.

ALIGNMENT BETWEEN MATHEMATICS TEACHER EDUCATORS' UNDERSTANDING OF FORMATIVE ASSESSMENT AND GHANA'S POLICY ON ASSESSMENT

Justice Enu
University of KwaZulu Natal

Abstract
This paper looks into the extent of alignment between mathematics teacher educators' understanding of formative assessment and policy on assessment in the context of Ghana. This qualitative, interpretive study was framed using the social-cultural theory of learning and was located at three teacher colleges in Ghana. Data generated from semi-structured interviews and textual materials (students' assessment scripts) were analysed using thematic coding and interpretive strategies. Four main themes with their corresponding categories emerged during the data analysis. The alignment of four different aspects of formative assessment captured in Ghana's policy documents was compared with mathematics teacher educators' understanding of formative assessment based on the themes generated during data analysis. The study established existence of a close alignment between policy and teacher educators' understanding in three areas: definition of formative assessment, the functional role of formative assessment, and formative assessment strategies. There was one misalignment – nature of feedback. The researchers therefore recommend a teacher support programme for educators on how to give feedback comments that move learning forward, in line with Ghana's policy on assessment.

LEARNING TO NOTICE LEARNERS' MATHEMATICAL THINKING WHILE CO-ENACTING INSTRUCTION

Janne Fauskanger & Raymond Bjuland
University of Stavanger, Norway

Abstract
The study critically examines in-service teachers' opportunities to develop their ability to learn professional noticing when co-enacting instruction. It focuses particularly on exploring what as well as how teachers notice when the participants pause the instruction by initiating a Teacher Time Out (TTO) in the enactment phase of learning cycles of enactment and investigation. Fourteen primary school in-service teachers collaborate with teacher educators and participate in TTO discussions. A framework of noticing was applied in the analyses with the aim of shedding light on the ways in which these discussions enable teachers to collectively learn to notice learners' thinking. Findings from the analyses of all the 189 TTOs reveal that in 45 of the TTOs, teachers made sense of individual learners' mathematical thinking (focused noticing), and also used evidence from the situation in the lesson to reason and elaborate on important teaching and learning issues based on learners' thinking (extended noticing). These are examples of higher-level noticing.

MATHEMATICAL INSTRUCTIONAL EXPLANATIONS WITH A SPATIAL COMPONENT

Vasantha Moodley, Craig Pournara & Michael Askew
University of the Witwatersrand

Abstract
The purpose of this paper is to advance the research conversation on the nature of instructional explanations by a proposal to include an "explanation with a spatial component" as a feature of an instructional explanation. Literature on instructional explanations focuses on either the written or the verbal form but not on both forms together. This paper illustrates two examples of "explanations with a spatial component." These explanations consist of what is written and how it is written on the chalkboard together with teacher's utterances to highlight explanations for different purposes. This is a component of an instructional explanation illuminated through a grounded analysis of transcripts of classroom observations of two teachers' lessons on two different mathematics topics.

A MULTIPLICATIVE REASONING INTERVENTION IN GRADE 2

Samantha Morrison
University of the Witwatersrand

Abstract
This paper reports on findings from a study focused on developing early multiplicative skills in a context of widespread low learner attainment in number. This study sought to understand the impact of intervention, focused around four carefully constructed lessons, that aimed to improve outcomes in multiplicative reasoning (MR) through attention to supporting learners'

construction of models. Positive learning gains achieved in a previous iteration of the study in another province provided the rationale for this study. Learner pre- and post-test data around the relatively short intervention show improved performance in terms of mean scores. Another important outcome is that this improvement in performance is associated with much greater inclusion of models of various sorts in learner responses in the post-test. This is an important finding in any context of highly inequitable learning outcomes coupled with 'lags' in number learning on the ground where not much attention has been given to learners' construction of models as a means to developing their mathematizing capacity.

SELF-REGULATION STRATEGIES USED BY FEMALE STUDENT TEACHERS IN PRIMARY MATHEMATICS TEACHER EDUCATION

Lisnet Mwadzaangati & Mercy Kazima
University of Malawi

Abstract

We discuss findings from an exploration of self-regulation strategies used by female student teachers to enhance their learning of mathematics, and the support they require to boost the effectiveness of the strategies. Data was collected using mixed methods; 523 female students from six public teacher colleges completed a questionnaire, and 160 of them participated in focus group discussions. The quantitative data was analysed using descriptive statistics while the qualitative data was analysed using thematic analysis. The findings reveal that the most common self-regulation strategies used by the female student teachers are group discussions, individual practice and asking other students for assistance. The most needed forms of support are clear explanations by their lecturers, more time to practice solving mathematics problems and more books and internet access. We argue that increasing female participation in mathematics should go beyond increasing numbers of females into the teacher colleges by also including support for their self-regulation learning.

Key words: self-regulation learning, female participation, female students, gender, Malawi, mathematics, primary teacher education.

AN EXPLORATION OF THE TEACHING OF CAPACITY IN GRADE 4 IN MALAWI

Liveness Mwale
University of Malawi

Abstract

This paper discusses findings from a case study which explored the teaching of capacity in Grade 4 in Malawi. Qualitative data was collected from a mathematics lesson using video recording. The study used Mathematics Discourse in Instruction (MDI) as its theoretical framework to explore the teaching of capacity. The MDI framework was chosen because it describes a lesson bit by bit, thereby analysing teaching shifts that take place in a mathematics lesson. This kind of analysis was useful in this study as it enabled a thorough understanding of how teacher's practises made mathematics available to learners.

The study established that while the lesson goal was to measure capacity of containers in millilitres and litres, the activities and tasks that took place in this lesson may not have prepared the learners fully to enable them to measure capacity. The activities involved the use of known capacities of smaller bottles to fill up bigger bottles. Based on this and other findings, the study suggests that more research needs to be done in Malawi and other countries to guide early grade teachers on how to teach capacity measurement to ensure that learners develop conceptual understanding and underlying skills important for mastery of measuring capacity.
Key words: Capacity, Mathematics Discourse in Instruction, early grade, Standard and non-standard units.

JUMPSTART PROGRAMME IMPACT ON MATHEMATICS LEARNING OUTCOMES: A CROSS-SECTIONAL QUASI EXPERIMENT USING THE EARLY GRADE MATHEMATICS ASSESSMENT

Nicky Roberts & Qetelo Moloi
University of Johannesburg

Abstract

This paper contributes to the research agenda on intervention studies and their impact on learning outcomes. It focuses on early grade mathematics in South Africa by drawing on four years of cross-sectional data (n = 5,724) from treatment and control primary schools in the same district in Gauteng. Early Grade Mathematics Assessments (EGMA) were administered to a random selection of learners in both school groups over a period of 4 years. Findings show a statistically significant difference in mean attainment on the EGMA assessment in the JumpStart schools (effect size of 0.52) and with further improvements evident after 3 years (effect size of 0.94). These effect sizes are compared to existing South African studies as well as meta-analysis of studies from low- and middle-income countries. Benchmarks for EGMA raw score attainment at Grade level in the Ekurhuleni South district of Gauteng (n = 2,625) are provided.

A CASE STUDY ON RESPONSES TO INTEGER ITEMS: A CHANGE IN ERRORS FROM GRADE 9 TO GRADE 10

Yvonne Sanders[1], Craig Pournara[1] & Graham Dampier[2]
University of Witwatersrand[1], University of Johannesburg[2]

Abstract

We report on changes in learners' performance and their errors with negatives and subtraction as they progress from the beginning of Grade 9 to the end of Grade 10. Using the same test instrument, a cohort of 60 learners in one school in Johannesburg was tracked and tested twice in both years. Using a mixed-methods approach, we explore the extent to which learners' performance improves on items relating to negative numbers and subtraction. Findings suggest that the ability of learners to use negative numbers and to subtract improve, but only in Grade 10. Findings also suggest that in Grade 9 learners struggle more when there are brackets in the item, and in Grade 10, learners operate more often with negatives.

EXPLORING CHALLENGES EXPERIENCED BY TEACHERS TEACHING NUMBER SENSE IN THE FOUNDATION PHASE

Roy Venketsamy[1], Scholastica Mamogale[2] & Zijing Hu[3]
University of Pretoria[1], University of Pretoria[2] & University of Johannesburg[3]

Abstract

Early number sense includes learned skills that involve explicit number knowledge. Teachers play a crucial role in developing learners' knowledge and understanding of number sense, however, most teachers experience challenges in teaching number sense in the Foundation Phase. This paper explores the challenges experienced by teachers and the calculation strategies they use to develop learners' number sense. A qualitative case study through the constructivist theoretical lens seemed best suited for this research. The research was conducted in Gauteng with six foundation phase teachers, two from each grade in one school. Findings revealed that teachers lacked knowledge, understanding and training on how to teach number sense. Results also identified the calculation strategies teachers used to develop learners' number sense. It is recommended that teachers receive on-going professional development on content, methods and approaches to teaching number sense. Furthermore, a recommendation for DBE to collaborate with higher education institutes for support **is** made.

Keywords: Early number sense (ENS); strategies; Foundation Phase; mathematics; constructivism

PRESERVICE TEACHERS' NOTICING OF CHILDREN'S ADDITION CALCULATION STRATEGIES

Lise Westaway & Pamela Vale
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Abstract

Number sense is the ability to think flexibly to use a variety of strategies appropriate for calculating. Engagement with mental mathematics is central to the development of mental models which enable the flexible use of strategies for calculating. Preservice teachers need to develop knowledge of how to support children's thinking through identifying and understanding the variations in their use of strategies. We focus on five key addition strategies in this paper: splitting, jumping, compensating, non-standard partitioning and re-ordering. We administered the Mental Computational Fluency with Addition assessment to 94 preservice teachers to assess their ability to notice the addition strategies used in calculations, and to ascertain whether there was a difference in their performance per strategy. The results showed that the preservice teachers relied particularly on splitting strategies and that there is need for the critical examination of the mathematics course in which the students are enrolled.

MATHEMATICS SHORT PAPERS

USING A COMPARATIVE JUDGEMENT APPROACH TO ASSESS THE PROBLEM-SOLVING SKILLS OF PRIMARY SCHOOL PUPILS

P Barmby[1], C Foster[2], I Jones[2], J Kelly[3], J Milinkocic[4]
No More Marking[1], Loughborough University[2], University of Cambridge[3], United Kingdom & University of Belgrade[4], Serbia

Abstract
Comparative judgement has been put forward as a way of assessing more open responses to mathematical questions, for example in problem solving. This paper describes a small-scale study involving a comparative judgement assessment of the problem-solving skills of 17 pupils from one primary school in England, with judgments provided by 10 teachers. The Scale Separation Reliability was 0.87, showing a high degree of accuracy in differentiating between the quality of responses. Examples of responses showed a valid progression in the problem-solving skills shown. Questionnaire responses from the teacher judges support the potential of the process to inform teachers and pupils of the range of approaches that can be used in such a task. In addition, through the built-in moderation process, comparative judgement can provide formative support in aligning teachers' views of problem solving.

Keywords: Assessment, Comparative judgement, Primary, Problem Solving

TEACHER GESTURES AND VERBAL LANGUAGE: AN INDISPENSABLE SEMIOTIC AND SYMBIOTIC RELATIONSHIP IN MULTILINGUAL MATHEMATICS CLASSES

C Chikiwa & M Schäfer
Rhodes University, South Africa

Abstract
Embedded in embodied cognition and enactivism this paper focuses on an analysis of how a selected Grade 11 teacher used gestures in conjunction with spoken language during the teaching of mathematics in a multilingual secondary school environment. We observed that there exists an intricate semiotic and symbiotic relationship between bodily actions, or gestures, and the spoken language. We thus argue that gestures can provide important and helpful tools to support multilingual teaching, if used appropriately.

Keywords: Gestures, multilingual, language, teaching, mathematics

A LINGUISTIC PERSPECTIVE IN SOLVING WORD PROBLEMS IN GRADE 3: WHEN ARITHMETICAL THINKING AND READING COMPETENCE COLLIDE

A Dlamini & E Henning
University of Johannesburg, South Africa

Abstract

Children's struggle with the solving of word problems is a perennial topic in mathematics education research. At the core of many studies is the issue of the structure of the problem situation which is sketched in linguistic 'notation'. Especially young learners are required to imagine the everyday setting portrayed in the problem sketch, while invoking their knowledge of mostly number operations and relationships while, at the same time, they have to process the vocabulary, grammar structures of the sentences and deduce meaning on the problem itself. The assumption is that these structures and the lexicon are sufficiently familiar to the young learners. Therein lies our argument: there is increasing evidence that children's working memory can be overloaded when they are reading word problems, to the extent that they cannot process the information systematically (Cockroft, 2015). The paper will discuss the findings of a study about solving word problems in grade 3 with a cohort of 58 learners in a public school in Soweto, South Africa. It delves into the linguistic factors that come into play when grade 3 learners engage with linguistically formulated mathematical problems in written text. The paper elaborates on the results of a custom-designed assessment tool, containing one storyline, with eight of the items assessing number knowledge directly, and the other three questions not related to mathematics. It discusses the data gathered from clinical task-based interviews with a stratified sample of 9 learners from the cohort of 58 learners. The main findings are discussed from a combined perspective of reading- and number concept development. It is evident that language proficiency and reading competence play an important role in the way children solve word problems.

Keywords: Numeracy, word problems, language proficiency, reading competence, reading skills, language competence, English medium of instruction, working memory.

EXPLORING FIRST-YEAR ENGINEERING STUDENT'S PRIOR KNOWLEDGE IN MATHEMATICS

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University of Johannesburg[1] South Africa, University of Kassel[2] and University of Regensburg[3] Germany

Abstract

In the following, we will briefly set the scene for this study, explain the research design, report on essential results, and discuss these findings. This paper reports on empirical results concerning the prior mathematical knowledge of first-year engineering students. An investigation over two consecutive years (2019 & 2020) is meant to yield interesting results

with the aim to determine: (i) the students' performance level in the beginning, and (ii) possible knowledge gaps that might highlight the necessity for additional strategic support for their future mathematics courses in general and for a mathematical modelling unit in particular. In 2019, 133 students in an extended curriculum programme were exposed to a carefully designed entrance test that consists of six content and knowledge components mainly from school mathematics, and in 2020, 555 students in the regular curriculum programme were exposed to the same test. Quantitative data were collected and t-tests for independent samples were used to compare the results; significant differences between the groups were found in four content areas. Overall, students were rather weak and unexpectedly the 2019 cohort outperformed the 2020 cohort.

THE RELATIONSHIP BETWEEN READING AND MATHEMATICS ACHIEVEMENT LEVELS IN BOTSWANA: AN EXPLORATION OF SEACMQ IV STUDY

K G Garegae
University of Botswana, Botswana

Abstract
The study explores a relationship between reading and mathematics scores of Grade 6 learners in Botswana school by using SEACMEQ IV data which was collected in 2013. The preliminary results indicate that there is an association between learners' reading and numeracy scores. Learners' English proficiency, school locality, frequency of English speaking outside school setting, and gender are some factors that influence performance achievement levels in both mathematics and reading levels. Furthermore, the study revealed that limited English proficiency has a profound effect on reading achievement levels than in mathematics scores. Further analysis is needed to investigate why mathematics learning seems not be affected very much by English proficiency.

MULTIMODAL ONLINE TEACHING: EXPERIENCE OF ENGINEERING MATHEMATICS STUDENTS

F George & E Rzyankina
Cape Peninsula University of Technology, South Africa

Abstract
Tertiary educators are expected to plan for adaptable schedules, changing pedagogical practices, and flexible learning and work environments that incorporate technology. The CoViD-19 pandemic accelerates the migration of face-to-face instruction methodology to online platforms. This is a case study exploring the accessibility and effects of a multimodal online teaching of marine engineering students at a University of Technology (UoT). The data will be analysed qualitatively and quantitatively. The results of this study will show that the

online teaching and learning resources are adequate to effectively deliver the curriculum and positively affect students' performance.

AFFORDANCES AND CONSTRAINTS OF USING PLACE-VALUE BOXES IN THE TEACHING OF TWO-DIGIT ADDITION IN GRADE 2

Fraser Gobede
University of Stavanger, Norway and University of Malawi, Malawi.

Abstract
This paper reports findings from a study involving a Grade 2 mathematics teacher who used hand-made place-value boxes when introducing the addition of 2-digit numbers. The lesson was video-recorded and analysed using the Mediating Primary Mathematics framework. Findings from the study show the potential of the place-value box in showing structural connections between several representations of the process of addition.

A FAMILY FOCUSED STORY-BASED APPROACH TO STRENGTHENING EARLY NUMERACY

Mellony Graven
Rhodes University, South Africa

Abstract
Local and international research highlights the advantages of using a narrative approach to support numeracy. Literacy research points to interactive reading approaches with early learners supporting academic learning trajectories. In this short paper I argue for using a dialogic reading story-based approach engaging with early numeracy in the home. I share findings, based on interview data from parents and carers, that show that this approach increases engagement with numeracy beyond the classroom. Such out of school learning opportunities assist in reducing the learning gaps between poorer under-resourced communities and wealthier highly resourced communities. In this paper and presentation, I briefly share the approach of the family math story-time program for Grade R learners and share the key findings from post program interviews with their carers.

AN EXPLORATION OF A SOUTH AFRICAN HIGH SCHOOL LEARNER'S NARRATIVE MATHEMATICS LEARNER IDENTITY

W M Hokonya, P Vale & M Graven
Rhodes University, South Africa

Abstract
The aim of this paper is to share insights into one learner's mathematical identity and how this has evolved through her landscapes of mathematical practice. We use Wenger's (1998) modes of belonging as an analytical framework to explore how the learner presents episodes of both

excitement and challenge in her learning trajectory. The narrative is dominated by the learner's affinity for mathematics despite the challenging episodes that she encountered during her journey.

TEACHING MULTIPLICATION USING REPRESENTATIONS: WHAT WORKS FOR PRIMARY PRE-SERVICE TEACHERS IN MALAWI?

Everton Lacerda Jacinto & Arne Jakobsen
University of Stavanger, Norway

Abstract
This article addressed the question: How do pre-service teachers in Malawi understand the teaching tasks and the knowledge necessary to teach multiplication using multiple representations? A case study was conducted with one female pre-service teacher attending a teacher education college program. Teaching observation and a post-lesson interview were conducted over her teaching practice, focusing on two themes of analysis considering the theoretical framing of mathematical knowledge for teaching: (1) using representations to teach multiplication, and (2) reflections on the knowledge used to conduct the teaching tasks. These themes revealed an understanding of teaching knowledge consistent with theoretical constructs but limited with practical applications. The study has implications for initial teacher education and further research on the topic.

Keywords: Malawian teacher education; teaching tasks; representations.

EXPLANATIONS ABOUT HOW TO TEACH PLACE VALUE MADE AVAILABLE FOR STUDENT TEACHERS TO LEARN

Justina Longwe-Mandala
University of Stavanger, Norway and University of Malawi, Malawi

Abstract
This study explores explanations made available in a mathematics teacher education class for student teachers to learn how to teach the concept of place value. It is part of a project aimed at exploring how mathematics teacher education prepares student teachers to teach number concepts and operations in early primary classes in Malawi. Six lessons were observed. This study focuses on the first lesson on the teaching of place value. Data was collected qualitatively. Analysis of the data indicates that talk was both mathematical and nonmathematical, and that the teacher educator provided explanations that provided opportunities for student teachers to learn how to teach the concept of place value.

A FRAMEWORK FOR ANALYSING PERCENT DISCOURSE

J Luksmidas & C Pournara
University of the Witwatersrand

Abstract
Adults and children are known to experience difficulty with percent. Using a commognitive approach, we propose a new framework for the development of percent discourse (PD). Integrating the cognitive work of Parker in which she identifies the significance of a percent-as-ratio context into an hierarchical discursive framework, we map the evolution of percent discourse as a succession of four PD-levels. The levels of the PD-framework are characterised by the words, visual mediators, routines and narratives observed as the development of percent discourse is mapped from talk about fraction to talk about ratio. We illustrate the use of the PD-framework to offer explanations for the difficulties observed in the discursive activity of two first-year university students.

FORM, STRUCTURE AND REPRESENTATIONS OF ALGEBRAIC EXPRESSIONS: WHAT IS THE EXPLANATION?

Nontsikelelo Luxomo
University of the Witwatersrand, South Africa

Abstract
The ability to interpret and connect multiple representations is an important and useful strategy which assists learners to understand the mathematics. However, representations, in their own right, have structure of which its understanding is essential before learners can gain fluency in working with and across multiple representations. The notion of multiple representations and structure are to a large extent research area that are often dealt with separately in the field while they both address a related and important educational concern. The goal of this paper is to examine the relation between the notions of form, structure and representations and how these together contribute to the idea of explanation. By recruiting Ruben's (1992) interpretation of Aristotle's second criteria of explanation, which is form, I elaborate the notion of structure of algebraic expressions. I use document data from the larger study which was empirically located in a professional development project. The results reveal that form and structure are synonymously used and completely depend on the nature of the representation. I argue that there is a need to study the notions of form/structure and representations jointly rather than separately.

ON MODELS FOR TEACHING DIRECTED NUMBERS

J P Makonye & V W Hlako
University of the Witwatersrand, South Africa

Abstract

This conceptual paper problematizes the teaching of directed numbers and associated operations. This conceptual study on research-based models on teaching directed umbers and associated operations is important because this topic is often very difficult to deal with for both teachers and learners. Several models are explored; the charged particle model, the sentry-robot model, the balloon model and others. These models have advantages and disadvantages but they help learners to make sense of the topic. This article helps to build mathematics teacher professionally situated knowledge in teaching this topic. The models have different strengths and limitations. The study is ongoing.

SUBITISING: A UNDERUTELISED MATHEMATICS CONSTRUCT IN PRESCHOOL MATHEMATICS TEACHING AND LEARNING

Kitso Maragelo
University of Johannesburg, South Africa

Abstract
This paper presents an overview of a review conducted on the literature informing the teaching and learning of early mathematics with a focus on subitising. The reviewed literature shows that subitising is an important mathematical component for preschool children. This paper analyses literature published in national and international journals on subitising. This paper highlights the gap in the use of subitising in early childhood development (ECD)with a focus on preschool settings. It provides a theoretical overview of an important – yet seemingly overlooked and underutilised - early learning construct: 'subitising'.

Key words: subitising, early mathematics

GENDER DIFFERENCES ON IMPACT OF GEOGEBRA AS A MANIPULATIVE TOOL AMONG GRADE 11 GEOMETRY LEARNERS IN SOUTH AFRICA

I.Y Marange, J K Alex & I Kariyana
Walter Sisulu University, South Africa

Abstract
This study sought to uncover possible gender differences in terms of learners' achievement after learning circle geometry using GeoGebra. The study adopted a quasi-experimental research design within a quantitative approach. The sample consisted of 60 Grade 11 mathematics learners. Pre-test, post-test and Likert-scaled questionnaire were used as instruments. Findings revealed that pre-test results did not show much differences in the performance of the group. In terms of perceptions, more females compared to males agreed that GeoGebra was an effective manipulative tool in learning circle geometry. However, learning using GeoGebra resulted in no statistically significant gender-based differences in academic performance though boys performed better than girls in the post-test. GeoGebra revealed male learners to be more creative and discovered skills of solving geometry problems

by themselves. The study concluded that GeoGebra had positive effects on learners' understanding as they became significantly active and responsible for their own self-directed learning.

Keywords: Gender differences, GeoGebra, Geometry, Information and Communication Technology, Manipulative, Mathematics

WHAT'S IN A NAME? FRACTION NAMING CONVENTIONS IN ISIXHOSA

Ingrid Mostert & Nicky Roberts
University of Johannesburg, South Africa

Abstract
Many learners, both in South Africa and internationally, struggle with fractions. One of the primary reasons why learners struggle is that they see fractions as two different unrelated numbers. When teaching fractions in English, this can partly be avoided by delaying the introduction of fraction notation of the form $\frac{4}{5}$ and by referring to 'four fifths' rather than '4 over 5'. Is a similar approach possible in other languages with very different grammars? In this paper four mathematics texts, translated into isiXhosa, are analysed in order to describe isiXhosa fraction naming conventions. The analysis shows that there are two primary conventions, one which is the same as the English 'four fifths' and the other which is similar to '4 over 5'. The affordances and constraints of both isiXhosa fraction naming conventions are described in relation to the English naming conventions.

DISRUPTING TRADITIONAL PEDAGOGY: EXPLORING STUDENTS' EXPERIENCES OF ONLINE PEDAGOGY FOR MATHEMATICS EDUCATION

J Naidoo
University of KwaZulu-Natal, South Africa

Abstract
The COVID-19 pandemic has forced universities to fast track online pedagogy. South African universities imbibed in structural failures left by complexities of the unequal apartheid education have to find credible solutions for online pedagogy. This study sought to explore mathematics education students' experiences of online pedagogy. The research was a mixed-method study located at one University in South Africa. The participants are second-year mathematics education students registered at the participating university but currently living in rural or semi-rural contexts during the COVID-19 pandemic era, the Communities of Practice theory framed the study. Qualitative methods were used to analyse generated data. The preliminary findings of this study reveal new knowledge on the challenges and strengths of online pedagogy as experienced by mathematics education students living in rural or semi-rural contexts.

Keywords: COVID-19; mathematics education; online pedagogy; rural context; semi-rural context

REFLECTING OR NOT REFLECTING: SECONDARY MATHEMATICS TEACHERS PERSPECTIVES

Z Ngcobo, S Ngema, S Bansilal & T Mkhwanazi
University of KwaZulu-Natal, South Africa

Abstract
Reflecting on practice is a paradigm that dominates teacher education around the world, and most professional teacher intervention programs include it as a way to improve teachers' practice. This article offers an analysis of secondary mathematics teachers' experiences of reflecting on their practice within an intervention programme in the province of KwaZulu Natal. Data presented here were generated from teachers in two districts in KwaZulu-Natal who participated in the JIKA imfundo project. Data were collected using surveys, interviews and document analysis. Findings show that reflection is a challenging activity for many secondary mathematics teachers. They consider reflections as unnecessary administration tasks that do not contribute to their professional growth and learner performance. Based on the findings, researchers recommend that teachers to be guided to design reflection tools that are meaningful to them and their context.

Keywords: Reflections; secondary mathematics teachers; reflective practice

DEVELOPING LEARNER-AUTONOMOUS MATHEMATICS LEARNING ENVIRONMENT (LAMLE) MODEL: A FRAMEWORK FOR CURRICULUM IMPLEMENTATION IN LESOTHO

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Abstract
Of late, educational reforms advocate for learner-centered teaching and learning approaches in mathematics education. In this paper we present a framework, Learner-Autonomous Mathematics Learning Environment (LAMLE) model which could be utilized in curriculum implementation. Our framework will be used to investigate the effects of learner-autonomous classroom environment on learners' development of conceptual understanding in Mensuration. We propose LAMLE model as a possible lens to interpret, describe and understand learners' behaviour (their discourses in particular) in an autonomous classroom environment as it relates to their development of conceptual understanding in Mensuration. Our model comprises a ternary of key learning theories: Commognition; Active learning perspective and Van Hiele's five – phase instructional sequence.

TEACHER TALK AS 'MODEL' AND 'SCAFFOLDER' IN SECOND LANGUAGE CONTEXTS OF MATHEMATICAL PROBLEM-SOLVING

Sally-Ann Robertson & Mellony Graven
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Abstract
Emphasis has increasingly been placed on the importance of providing young mathematics learners with opportunities to engage in discussion en route to their making mathematical meaning. Research indicates, however, that learner talk in contexts where teaching and learning takes place predominantly in and through a second language is severely constrained. In consequence, teachers tend to do most of the talking. A predominance of teacher talk is frequently construed in negative terms. Counter-arguments might view such talk as both inevitable and necessary, particularly where learners lack proficiency in the language of teaching and learning. We argue that much depends on the nature of the teacher talk and on what additional modes of communication are simultaneously in play.

HOW TEACHERS INTRODUCE ALGEBRA IN PRIMARY SCHOOLS IN MALAWI: A CASE STUDY OF THREE TEACHERS IN STANDARD 5

Kolace Silwimba & Arne Jakobsen
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Abstract
This study investigated how teachers introduce algebra to Standard 5 leaners in Malawi. The study is a qualitative descriptive case study, and the sample consists of three Standard 5 mathematics teachers from three primary schools in a district in central Malawi. Data comprises of video recording of the teachings and lesson plans as documents, which are analysed using the Mathematical Discourse in Instruction framework focusing on resources, exemplification and explanations. The study findings show that the three teachers used a traditional "fruit salad" approach of introducing algebra, interpreting letters as names of objects. The examples, tasks and explanations were of level 1.

VISUAL TEACHING OF WORD PROBLEMS FOR CONCEPTUAL UNDERSTANDING IN GRADE 9

Bernard John Ssennyomo & Clemence Chikiwa
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Abstract

Using the social constructivist perspective, this case study analyses visual teaching of Pythagoras Theorem word problems in schools in the John Taolo Gaesetwe (JTG) District. Quantitative data were collected using a survey with eighty-seven participants while qualitative data were collected through classroom observations and interviews of three purposively selected teachers. The three teachers who took part in the intervention programme demonstrated and manifested some changes in their teaching approaches. We thus conclude that such an intervention may need to be done with all the teachers in the district, specifically focusing on choosing and using visuals to teach specific topics for conceptual understanding.

EXAMINING TEACHERS 'PEDAGOGICAL CONTENT KNOWLEDGE IN TEACHING PROPORTIONS TASKS

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Abstract

This paper examines two aspects of teachers' pedagogical content knowledge as it is reflected in responses to three tasks concerning the teaching and learning of fractions, percentages, and pie charts. An instrument containing both closed and open-ended questions was distributed to seventy-five mathematics teachers from one South African province. The findings revealed that teachers possess insufficient Content Knowledge and Knowledge of Teaching. The correlations between the two knowledge categories are weak or non-existing, but content knowledge does appear to limit teachers' PCK. Teachers as important knowledge drivers are demanded to attend professional courses to improve their PCK.

Keywords: content knowledge, Content knowledge and Teaching, correlation

THE INFLUENCE OF LENGTH MEASUREMENT ESTIMATION ACTIVITIES ON GRADE 3 LEARNERS' NUMBER LINE ESTIMATION

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Abstract

In this paper I reflect on the connection that can be made between length measurement estimation and number line estimation and show how length measurement estimation activities acted as a vehicle for connecting and linking to the topic of number. I explore the performance of a group of Grade 3 learners in South Africa on a series of number line estimation tasks done after participating in the Fraction as Measure sequence. Shifts were evident in learner performance on the number line estimation tasks, despite number lines not being mentioned during the instructional sequence.

MATHEMATICS POSTER PAPERS

THE USE OF VISUAL IMAGES IN MULTIPLICATION AND DIVISION IN THREE SOUTH AFRICAN FOUNDATION PHASE MATHEMATICS TEXTS

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Abstract
Workbooks and textbooks assist learners and teachers in building bridges by offering visual representations and symbols that assist learners in their understanding of mathematics (Liebeck, 1984). We use vision to make sense of the world around us (Arcavi, 2003). Mathematics texts contain many visual representations. The main research question which guides the research is: "What is the nature of the visual representation used to support foundation phase learners understanding of multiplication and division in South African texts?" A tool designed by Fotakopoulou and Spiliotopoulou (2008) will be used to analyse the nature of the visual representations of grade 1-3 texts. These include the Department of Basic Education (DBE) workbooks and textbooks from two South African publishers.

VISUALISATION PROCESSES IN THE TEACHING OF SECONDARY SCHOOL MATHEMATICS: EXPERIENCES OF PGCE PRE-SERVICE TEACHERS

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Abstract
This proposed study aims to understand mathematics pre-service teachers' practices related to use of visualization processes. The study targets PGCE students who are registered for a Mathematics Methods course. The study also aims to look at these teachers' processes in designing mathematical tasks prior to and during teaching practice. This same process also deepens their own mathematics content knowledge as well as pedagogical knowledge. Lastly, the study endeavours to help students improve the quality and quantity of their portfolio content.

ONLINE MATHEMATICS TEACHING DURING COVID-19 PANDEMIC IN TEACHER-TRAINING INSTITUTIONS: A QUESTION OF INTERACTIVE DISCOURSE

Sechaba Koma & Sikeme Raphoka
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Abstract
The world has been hit by COVID-19 pandemic which among others, forces people to stay away from other people and avoid gatherings of many people in small places to prevent infections. This situation calls for online education for advancement of knowledge acquisition and syllabus coverage. Although online educations seem to be ideal, there are a number of challenges involved in the usage of online education. These include challenges related to training of instructors and learners in use of online technology, internet connectivity and online pedagogical knowledge. Three instructors and four learners from two teacher-training institutions partook in this study by responding to semi-structured interviews and questionnaires. The purpose of this study was to investigate how teacher training institutions in Lesotho implemented online education during COVID-19 crisis and evaluate its effectiveness so as to recommend its incorporation when preparing future teachers.

SHARPENING THE FOCUS ON PROBLEM SOLVING: EXPLORING PRE-SERVICE MATHEMATICS TEACHERS PEDAGOGICAL CONTENT KNOWLEDGE AND IT USE IN CLASSROOM PEDAGOGY

A K Boateng Ofosu & J K Alex
Walter Sisulu University, South Africa

Abstract
This exploratory study is undertaken against the background of the very poor overall achievement of high school learners in the national matric examination and in international assessment studies, which is currently a cause for great concern. Hence, the purpose of this study is to explore and determine the modes of acquisition of pre-service mathematics teachers' pedagogical content knowledge within their teacher training developments in order to obtain insight into their understanding of the teaching and learning of mathematics. This study uses the pragmatic mixed method research design with a survey research and multiple case study approaches. The research instruments include questionnaires, interviews, lesson observation, and intervention workshops. In total, the study purposefully sampled 60 pre-service mathematics teachers doing teaching practice in 8 schools in the O.R. Tambo Inland District. The study has implications for the teachers' community of practice to share their teaching practices to improve their mathematics pedagogical content knowledge, and therefore improve students' learning of mathematics.

Keywords: Mathematics, pedagogical content knowledge, pre-service teachers, problem solving

MATHEMATICS SNAPSHOT PAPERS

AN ANALYSIS OF LEARNING TRAJECTORIES WITH RATIONAL NUMBERS IN SOUTH AFRICAN TEXTBOOKS

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Abstract
It is evident that textbook based learning is at the forefront of education in South Africa. Confrey's (2009) rational numbers learning trajectories on equipartitioning serves as a state-of-the-art analytical tool for teaching and learning around rational numbers. By means of document analysis, this research will be comparing the most commonly used maths textbooks in South African classrooms to the standards as set in Confrey's (2009) hypothetical learning trajectories to analyse, identify and eliminate gaps in order to enhance teaching and learning of rational numbers, more specifically "equipartitioning" with regard to fractions.

MULTIMODAL ONLINE TEACHING: EXPERIENCE OF ENGINEERING MATHEMATICS STUDENTS

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Abstract
Tertiary educators are expected to plan for adaptable schedules, changing pedagogical practices, and flexible learning and work environments that incorporate technology. The CoViD-19 pandemic accelerates the migration of face-to-face instruction methodology to online platforms. This is a case study exploring the accessibility and effects of a multimodal online teaching of marine engineering students at a University of Technology (UoT). The data will be analysed qualitatively and quantitatively. The results of this study will show that the online teaching and learning resources are adequate to effectively deliver the curriculum and positively affect students' performance.

ANALYSIS OF THE TEACHING CONTENT AND ITS ORDER WITH REGARD TO FRACTIONS IN THREE EASTERN AND SOUTHERN AFRICAN COUNTRIES: FUNDAMENTAL STUDY OF MATHEMATICS CURRICULA IN AFRICAN COUNTRIES TO ACHIEVE GOAL 4 OF THE SDGS

Satoshi Kusaka
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Abstract

Understanding the meaning and computation of fractions is one of the most important and difficult area in primary mathematics. However, there has been little basic research on the content in the curriculum of African countries. This study aims to clarify what features and difficulties are involved in learning fractions in African countries through comparative analysis. We found that for all three countries, whereas addition and subtraction of fractions and types of fractions are handled separately by different school grades, multiplication and division are all taught in one grade. Further, in all the countries, part-whole fractions are mainly used, and fraction as measurement are not taught at all. As a result, students' understanding of fractions will be very narrow. Poor arrangement of learning content of multiplication and division of fractions, and neglect of fraction as measurement can be the major causes of difficulty in learning fractions.

USING MUSIC TO TEACH FRACTIONS

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Abstract
Integration is a recurring theme throughout South Africa's various post-apartheid curriculum revisions. These revisions have highlighted the need not only to develop learners' understandings of mathematical concepts, but also the importance of achieving broader curricular aims concerned with recognising mathematics as a creative part of human activity. I argue for the need to explore ways whereby integration of mathematics and music could help teachers meet these curriculum aims. Drawing on findings from my Master's degree action research case study, I explain and justify my argument.

POOR MATHEMATICS PERFORMANCE IN GRADE 9 IN SOUTH AFRICA: THE CURRICULUM MAY BE PART OF THE PROBLEM

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Abstract
It is well-known that Grade 9 performance in mathematics in South Africa is poor. National and provincial initiatives to address the situation are based on the assumption that the problem lies with low levels of teacher knowledge, poor teaching and under-prepared learners. While these are central factors, little attention has been given to the role of the curriculum. The impact of the COVID-19 pandemic and the need for curriculum content reduction forces us to reconsider what constitutes core mathematical knowledge and skill in each grade. In this paper I provide evidence, drawing from a sample of over 5000 learners in under-resourced schools and over 750 learners in top performing well-resourced schools, that there are sections of the Grade 9 curriculum which neither group is coping with. In some instances, this content can be moved to Grade 10. In other instances, there needs to be greater attention to key mathematical transitions and to learners' difficulties.

MATHEMATICS SYMPOSIUM

REFLECTION ON AN INNOVATION: SAARMSTE'S 2020 VIRTUAL RESEARCH SCHOOL

M Rollnick[1], P W Hewson[2], H Venkatakrishnan[1], T Morar[3], A Msimanga[4], J A Luft[5], Z Nhase[6], F Lubben[7], P Gates[8], E Mavhunga[1], S Mupfawa[1]
University of the Witwatersrand[1], University of Wisconsin[2], Nelson Mandela University[3], Sol Plaatje University[4], University of Georgia[5], Free State University[6], University of York[7], University of Nottingham[8]

Abstract
In 2020 as the corona virus pandemic swept through the world, the SAARMSTE Research Capacity Building Committee, like many other educational institutions, decided an in-person Research School (RS) was impossible. The challenge was to design an experience that captured as many RS features as possible within a virtual environment. The aim of this symposium is to present the analytic reflections of various stakeholders, including the scholars and facilitators in the light of the history of the RS in order to respond to the following questions:

What are the affordances and constraints of a virtual RS compared to a face to face RS?
How should the experiences of a virtual RS inform the way forward?

SCIENCE LONG PAPERS

THE COVID-19 PANDEMIC: TIME FOR CRITICAL STEM LITERACY

Martin Braund
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Abstract
The COVID-19 pandemic has necessitated communication of STEM information on an unprecedented scale. This paper is a polemic, arguing for Critical STEM Literacy that is personally empowering for knowledge of a health crisis and to critique political policy decisions. Examples are from the United Kingdom discussing ways in which STEM issues have been communicated and interpreted. Of particular relevance are ways data have been translated as different types of graphs and mitigation by social distancing and wearing face masks to limit spread of SARS-CoV-2. Critical discussion of the science providing believable

truths and the ways in which complex wicked problems require deeper engagement of the public argue for STEM education that emphasises critical thinking, is socially just, and global.
Keywords: COVID-19, STEM literacy, public understanding, critical literacy

PHYSICAL SCIENCES LEARNERS' AND TEACHERS' PERCEPTIONS OF LEARNING STYLE-BASED INSTRUCTIONAL STRATEGIES

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Abstract
Physical science at the secondary school level has been a national priority in South Africa due to the growing awareness about its contributions to technological development of the nation. However, the performances of learners over the years have not been encouraging. This study therefore is part of a bigger project which investigated physical science teachers and learners' perspectives about learning style-based instructional strategies in the teaching of Electricity and Magnetism among grade 11 learners in schools around Mthatha to improve learner performance in the subject. To achieve the intended objective and to answer the research question, a purposive sample of 16 high school physical sciences learners and four physical sciences teachers were selected for the study. A collaborative case study design was adopted for the study. The research instruments included an in-depth semi-structured interview. Qualitative data were analysed using a thematic content analysis process. The study found that learners and teachers have a positive attitude towards learning style-based instructions as it improved learner achievement in Electricity and Magnetism. It is therefore recommended that teachers should use appropriate instructional strategies that would be congruent with the learners' learning styles for effective teaching and learning to take place in the physical science classrooms.

Keywords: Learning styles, learning style-based instructions, perceptions, physical sciences

INVESTIGATING SCIENCE STUDENTS' WATER LITERACY IN RELATION TO A LOCAL STREAM: A CASE STUDY OF ONE HIGH SCHOOL IN LERIBE, LESOTHO.

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National University of Lesotho

Abstract
Water is a critical part of environment, and its global significance is reflected in the UN SDGs, adopted by member states in 2015 to achieve environmental sustainability. This study investigated grade 10 science students' water literacy in relation to their local stream using water literacy theory. The aim of the study was to find students' knowledge of the health of their local stream and the associated biological indicators, and stream-related socio-economic problems and possible solutions to them. The study employed a case study design, 40 grade 10 students participated. Data were analysed qualitatively and quantitatively, to determine themes,

patterns and frequencies. The results show that many students had sound water literacy in terms of their ability to identify water-related problems and willingly to take action, but had limited water literacy on safety and quality of water.

Key words: Water literacy, Science Curriculum, Water quality, awareness

OPERATIONALIZING THE GRAND PCK RUBRIC: A CASE OF DEVELOPING A CLASSROOM RUBRIC FOR PORTRAYING ETSPCK IN CHEMISTRY

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Abstract

This study outlines the development of a rubric to portray the quality of enacted Topic Specific Pedagogical Content Knowledge (TSPCK) in classroom teaching. The rubric is based on the observation of visible TSPCK component interactions in enacted lessons. Primary data were the observations of two consecutive lessons of three experienced physical science teachers, which were video recorded. Teacher interviews complemented the data. The analysis process entailed in-depth qualitative method capturing displayed TSPCK episodes and providing thick descriptions of their characteristics by three raters. These were in turn, translated into criteria for the emerging TSPCK quality categories. The reliability of the rubric was further established through the Kappa-Cohen inter-rater reliability index calculated at 0.82, 0.82 and 0.80, respectively. The resulting analysis led to the formulation of a comprehensive, more sensitive 5-quality category rubric with the option to refine it into an overview rubric with 3 category rubric.

Keywords: Pedagogical Content Knowledge, Topic Specific PCK, TSPCK classroom rubric

HOW SECONDARY STUDENTS USE SELF-REGULATION IN LEARNING BIOLOGY

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Abstract

The paper reports on a study which explored how secondary students use self-regulation whilst learning biology. An instruction model that aims at fostering the development of self-regulation called, Plan, Organise Monitor and Evaluate (POME), was used to develop a questionnaire to find out what self-regulation strategies students use and how these varied with gender and years in school. The questionnaire was augmented with face to face interviews. 385 students from four boarding schools in Zomba responded to the questionnaire and a total of 16 students were interviewed. The findings showed that whilst both year 9 and year 11 students reported the use of plan, organise and monitor strategies, there was not much difference between year 9 and year 11 students, suggesting limited development over the secondary school years

Key words: Self-regulation, Metacognition, learning strategies, Plan, Organise, Monitor, Evaluate

THE VALUE OF INTEGRATING THE UN SUSTAINABLE DEVELOPMENT GOALS WITH A MICROSCALE EXPERIMENT FOR CHEMISTRY STUDENTS

Christine Mundy
University of Pretoria

Abstract

The United Nation's sustainable development goals (UN SDGs) are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. Microscale chemistry kits already comply with many of the UN SDGs as they are greener, safer and more cost effective than traditional large-scale laboratory experiments. This qualitative study explored the value added for first-year chemistry students when the UN SDGs were integrated in a microscale experiment on industrial pollution: students were able to identify and explain relevant UN SDGS and communicate chemistry in context. Many students showed retention of the relevant UN SDGs two months after completing the experiment despite having no prior exposure to the UN SDGs. The majority of students felt that their laboratory experience was enriched by the inclusion of the UN SGDs, wished to learn more about the UN SDGs, and endorsed their inclusion as a graduate attribute.

Keywords: South Africa; chemistry; sustainable development; UN SDGs; microscale

SCIENCE SHORT PAPERS

A METHOD TO ANALYSE PERSONAL MEANING MAPS TO ASSESS THE INFORMAL LEARNING OF BIODIVERSITY

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Abstract

Despite the rising popularity of Personal Meaning Maps (PMM), a derivative of concept maps introduced as an evaluation tool for learning in Informal Learning Settings (ILS), a rigourous method to analyse them has not yet been established. In PMMs, individuals are free to write about the meanings they personally make with a topic and many interpretations may be correct. The absence of a benchmark becomes challenging for practitioners who have to assess the success of an informal educational intervention and the analysis technique demands more rigour. This paper describes how PMMs were qualitatively and quantitatively analysed for their contents to establish learning about biodiversity among 13 students who participated in a guided tour to a nature reserve. The exhibits and biodiversity concepts learnt by students were

identified and recommendations are presented for improving the guided tour to enhance learning of biodiversity.

SCIENCE EDUCATION LECTURERS' PRACTICES IN PREPARING PRE-SERVICE TEACHERS FOR COMPETENCY BASED EDUCATION: A CASE STUDY OF ESWATINI TEACHER TRAINING COLLEGES

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Abstract

This study sought to explore whether and how lecturers use appropriate teaching and assessment methods for teaching according to a Competency Based Education (CBE) approach in teacher training colleges. In CBE lecturers are expected to emphasis the use of learner-centred approaches and also assess students using portfolios. CBE is a set of specific attributes such as skills and knowledge associated with successful performance This study attempted to answer the following research question: How do science lecturers teach Science and what are the implications on students-teachers' readiness to teach according to CBE? Three lecturers were selected using convenient purposive sampling for a qualitative study. A constructivist learning theory was used as the theoretical framework. Data was collected using an unstructured interview and open-ended questionnaire. Data was analysed using the content analysis whereby data was coded and themes were drawn from the data. The findings from the study revealed that lecturers predominately use traditional methods and exposure of students to learner-centred approach is limited. Students are not adequately equipped with skills to teach according to the CBE on completion of their programme.

Keywords: competency-based education, learner centred approach, curriculum development

THE IMPACT OF LOCKDOWN ON AUTHENTIC-LEARNING OPPORTUNITIES OFFERED BY LABORATORY-PRACTICALS AND THE DEVELOPMENT OF SCIENCE IDENTITY

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Abstract

This study examines the authentic-learning opportunities offered by laboratory-based studies, and the influence of this on the students' development of Science Identity. The focus here is the extent to which the development of Science Identity could be impacted due to lockdown. Data were collected via a questionnaire, and thematic analysis applied to qualitatively analyse data. 308 first years in biology responded to a questionnaire in 2018 and 2019. Findings indicated that, prior to lockdown, students perceived learning benefits offered by laboratory

activities. Their limited skill in this area caused for challenge in their transition, and this impacted on their confidence in carrying out scientific tasks. But their involvement in practicals had positive bearing for their development of their Science Identity in first year. These opportunities were drastically reduced in laboratory-based disciplines due to lockdown; implications are postulated.

Keywords: authentic-learning, Science Identity, lockdown, first years, biology

GENERAL FACTORS INFLUENCING AGRICULTURAL SCIENCE TEACHERS' CHEMISTRY TEACHING IN RURAL SCHOOLS – TIME FOR DISRUPTION

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In Agricultural Sciences, the teaching of chemistry is becoming an area of concern among Agricultural Sciences educators who are teaching in rural schools. This qualitative study explored factors influencing Grade 11 teachers' teaching of chemistry. Three rural teachers were purposefully selected. Data collection and generation for this study was mainly done through participatory focus group interviews. The interviews were transcribed, data coded and themes emerged from this data analysis. The findings, amongst others, indicated that several general factors influenced their teaching of chemistry in complex ways.

TRENDS IN ACADEMIC PERFORMANCE OF GRADE 12 LEARNERS IN LGCSE PHYSICAL SCIENCE FROM 2014 TO 2018

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Abstract

The research describes the trends of grade 12 learners' academic performance from 2014 to 2018 in LGCSE Physical Science examinations, observations and recommendations of examiners of 2018. Data collected from learners' performance in examinations the five years and examiners' reports of LGCSE Physical Science in 2018; from (ECoL) Examinations Council of Lesotho. Design is descriptive using both qualitative and quantitative methods of analysis. From the quantitative data, it is observed that pass rate is declining. Thus, the trend of performance in LGCSE Physical Science from 2014 to 2018 is decreasing. The qualitative data from examiners' reports attributes the poor performance to lack of the following: exposure to experimentation, technical and scientific language, understanding of the new curriculum and the skills it requires. It is recommended that NCDC provides more in-service support to teachers such that the attained curriculum is achieved.

INVESTIGATING OPPORTUNITIES FOR INTEGRATING METHODOLOGY WHEN TEACHING A BIOLOGY TOPIC (MEIOSIS) TO FOURTH YEAR PRE-SERVICE TEACHERS: A CASE STUDY

R. R. Kahn & E. Nyamupangedengu
University of the Witwatersrand, South Africa

Abstract

Developing Pedagogical Content Knowledge (PCK) in an integrated manner is a challenge for pre-service teachers (PSTs) as content and methodology are taught as separate courses at teacher education institutions. The aim of this study was to find out if the teaching of the two courses can be integrated. The participants were fourth year pre-service teachers and a biology teacher educator. Video-recordings of meiosis lectures; video stimulated recall interviews with the TE and focus group interviews with fifteen PSTs were the data sources. Data analysis was both deductive and inductive and the model of PCK by Mavhunga and Rollnick (2013) was used as a conceptual framework. The results show that the teacher educator created many opportunities for teaching how to teach in her teaching of content and PSTs gained PCK. The study therefore concludes that it's possible to integrate methods when teaching a content course to enable PSTs to develop PCK in an integrated manner.

EFFECTIVENESS OF TARGETED WEB-BASED INSTRUCTION IN ENHANCING GRADE 4 LEARNERS' UNDERSTANDING OF ASTRONOMY

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Abstract

Young learners often use naïve, rather than normative ideas to interpret Astronomy concepts, which leads to limited comprehension of the concepts. The prevalent use of traditional teaching methods to teach Astronomy could partly account for this inadequacy. Web-based instructional approaches, which explicitly demonstrate Astronomy concepts in an authentic manner, could enhance learners' understanding of the concepts. This study investigated the effectiveness of Targeted Web-Based Instruction (TWBI), in enhancing learner performance in Grade 4 Astronomy. A quantitative research approach, involving a quasi-experimental non-equivalent pre-test–post-test control group design, was used to collect data. The sample consisted of 55 Grade 4 learners; 27 in the experimental group, and 28 in the control group. The findings revealed that TBWI was as effective as traditional teaching methods in improving learner performance in Astronomy, despite several constraints.

Keywords: Web-based instruction (WBI), Targeted Web-based Instruction (TWBI), Astronomy, achievement, and traditional teaching methods.

THE IMPLEMENTATION OF CONTINUOUS ASSESSMENT BY ONE PRIMARY SCHOOL SCIENCE TEACHER IN LESOTHO: A CASE STUDY

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Abstract
Lesotho introduced continuous assessment (CASS) in 2012 to improve the quality of classroom instruction in science. Since then, however, the performance of science has not improved significantly. This study explored how primary school science teachers have understood the classroom implementation of CASS. Document analysis revealed discourses advocated by the Curriculum and Assessment Policy (CAP). The interview and classroom observations of a Grade 6 teacher as an informant in the case study revealed that teachers construct their own understanding of CASS to simplify learning. The study concludes that the environment within which CASS is enacted and the ability of teachers to navigate various aspects of instruction are strong determinants of effective implementation of CASS. The study recommends continuous training of teachers to enable them to adapt the assessment framework to their school contexts.

Keywords: Continuous assessment, classroom instruction, curriculum and assessment policy, formative assessment

EXPLORING TEACHER TALK MOVES IN SCIENCE LESSONS

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Abstract
In this paper, we report on an analysis of two science teachers' talk moves and how they shaped learner interaction and engagement with content. Data was collected through video-recording of the classroom talk. Teacher talk moves were analysed in three lessons in each case using the frameworks of Analysing Teacher Moves (ATM) and teacher discursive functions. The key finding of this study is how teachers used these two categories of teacher talk moves in complementary ways creating unanticipated learner interactional and engagement patterns. There were instances where closed initiating questions would result in prolonged interaction as the teacher employed persistent clarifying rejoinders. Similarly, some open-ended initiating questions yielded low learner engagement depending on the other moves that accompanied them. We discuss the value of understanding this intricacy of teacher move patterns and its implications for teacher education and professional development of science teachers.

EXPLORING THE DEVELOPMENT OF THE POST-GRADUATE PRE-SERVICE TEACHERS' PLANNED TOPIC SPECIFIC PCK OF CHEMICAL EQUILIBRIUM

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Abstract

Pedagogical content knowledge (PCK) is considered a valuable knowledge base for all science teachers. Thus, promoting its development in all pre-service teacher (PST) programmes including the short 1-year PGCE is desirable. The purpose of this study was to investigate the development of PGCE pre-service teachers' (PPSTs') topic specific PCK (TSPCK) in all its dimensions as planning-, enacted- and its influence on learner outcomes in Chemical Equilibrium. This paper however reports only on the development of the cohort's TSPCK in the realm of planning through an intervention. The intervention was conducted in the PGCE chemistry methodology course that targeted the development of TSPCK in science topics. Collected data comprised of pre-post TSPCK tests and content representations (CoRes). Qualitative in-depth analysis was employed yielding preliminary findings that revealed an improvement in the PPSTs' quality of planned-TSPCK. This improvement implies an increased quality in depth of teacher explanations and sound reasoning.

UNDERSTANDING SCIENCE TEACHERS' VIEWS AND EXPERIENCES IN A VIRTUAL ENVIRONMENT

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Abstract

With emergence of covid-19 pandemic schools were closed until further notice. As a way of mitigation, online teaching and learning through National television programs was introduced. However, teachers who volunteered to present had little to no experience with online teaching but with face-to-face teaching. Scholars warn that virtual environment is unique requiring special form of teaching. This case study attempts to understand teachers views and experiences in virtual environment. Four science teachers participated. Data were collected through structured interview over telephone and then analysed for emerging themes. Findings showed that teachers relied more on face-to-face classroom experience and intuition to plan and present lessons. They viewed virtual environment as offering them new insights into planning and delivery of lessons.

KNOWLEDGE-BUILDING IN THE SOUTH AFRICAN PRIMARY SCIENCES CURRICULUM: KNOWLEDGE ABOUT DAY/NIGHT CAUSES

Ngonidzashe Mushaikwa, Leanne Rusznyak, & Emmanuel Mushayikwa
University of the Witwatersrand, South Africa

Abstract

Debates about whose knowledge should be taught in schools is problematic in that at the end of schooling, we hope to be empowered by powerful knowledge which enables us to earn respect from our peers and our families. Primary education forms the basic foundation upon which further learning happens. In this paper, we argue that knowledge-building in every topic taught should be systematic, well sequenced and connecting content learnt before with new content. The education system is concerned with learning of theoretical knowledge that is deemed valuable due to its explanatory powers. Knowledge-building which is cumulative can be achieved over time. Thus, we analyse the development of the primary sciences curriculum's day and night cycle topic to understand the nature of knowledge building. We argue that although knowledge progression is promoted in the curriculum, and there is evidence of development from 'simple to complex,' the development does not seem to be continuous and connective. However, content seem to be cumulatively developing with a Grade but not across grades.

Keywords: cumulative knowledge, curriculum, day/night causes, knowledge, knowledge-building

PERCEIVED TEACHERS' SUBJECT CONTENT AND PEDAGOGICAL KNOWLEDGE OF THE INQUIRY AND TECHNIQUES USED IN TEACHING AND LEARNING OF BIOLOGY IN RWANDA SECONDARY SCHOOLS

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University of Rwanda-College of Education (UR-CE), Rwanda

Abstract

The inquiry teaching methods are appreciated for enabling learners to develop higher order thinking skills and solve daily life problems. However, previous studies reported poor integration of daily life issues and inadequate opportunities for skills development. In light of this, the present research aimed at investigating teachers' knowledge of plant reproduction, pedagogical knowledge of inquiry and techniques applied in teaching and learning of plant reproduction in Rwanda secondary schools to reveal if inquiry techniques are used. This was achieved using the Pedagogical Content Knowledge (PCK) framework. Biology teachers teaching in senior four and schools having at least a combination with a biology subject were purposively selected. Data were collected through a survey questionnaire administered to thirty-two teachers from thirty-two secondary schools located in four districts of Southern Rwanda. Collected data were statistically analysed by computing the percentages from the

rated statements to reveal the knowledge on plant reproduction, the Inquiry-Based Learning (IBL), and techniques used in teaching and learning as perceived by teachers. Results showed positive perception of teachers' content, IBL and used techniques as rated by the majority of teachers. However, there is a need to strengthen teachers' pedagogical skills of using IBL as identified by this study.

Keywords: Inquiry-based learning, subject content knowledge, pedagogical knowledge, teaching and learning biology

CONCEPTUALISATION OF CONTENT KNOWLEDGE RELATED TO TEACHING SCHOOL SCIENCE: A SYSTEMATIC LITERATURE REVIEW

B P Ndlovu & E M Mavhunga
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Abstract

It is widely accepted that there are fundamental differences between academic disciplines and school subjects, yet pre-service teachers are taught in broad academic discipline content knowledge geared for mainstream science careers. This study argues for a special academic content knowledge that is tailored for the development of prospective science teachers, and reports herein on the first phase of conceptualizing such content knowledge. The study followed a Systematic Review of relevant literature to conceptualise the desirable content knowledge as a theoretical construct called Teacher related Science Content Knowledge (TerSCK). Preliminary findings point to TerSCK being derived from the logical dimension connecting academic discipline and school science.

COVID-19 PANDEMIC TIME LEARNING ASSESSMENT. REPORTS OF BIOLOGY STUDENTS AT THE PEDAGOGICAL UNIVERSITY OF MAPUTO, MOZAMBIQUE

Agnes Clotilde Novela & Ana Bela Bernardo
Maputo Pedagogical University, Mozambique

Abstract

This research was developed with the main objective of evaluating learning in the periods in which the first and second state of emergency took place. This evaluation was based on reports from the students of the Undergraduate Course in Biology teaching of the Pedagogical University of Maputo. For the data collection, an online questionnaire survey was applied to an unknown universe. The main questions aimed to evaluate the students' experiences during the beginning of the state of emergency in addition to their suggestions for improving learning if the pandemic situation extends for longer. 52.7% of the students said it was difficult to adapt to the new modality due to lack of mastery of technologies, 43.6% said it was easy, 3.6% said

it was difficult due to lack of an electronic device. The other difficult was internet access and the lack of interaction with teachers. With this research, it was concluded that the students faced many difficulties of a technological nature.

Keywords: Learning, Covid-19 times, Reports.

PERSPECTIVES OF PHYSICS TEACHERS ON IMPLEMENTATION OF PROBLEM-BASED LEARNING IN HIGH SCHOOLS

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Abstract

The perspectives of physics teachers about problem-based learning (PBL) have been investigated. To achieve this, semi-structured interviews were used to collect qualitative data from 16 teachers in 8 purposive selected schools. The findings of the study indicate that teachers are positive about the implementation of PBL since it focuses on real-life problems. In addition, it provides opportunities to develop problem-solving skills, critical thinking skills and self-directed learning in learners. However, teachers suggest they may probably not use it because it requires a lot of time and is difficult to develop an investigating question and to organize the entire process.

Keywords: Problem-based learning, problem-solving skills, critical thinking skills, self-directed learning, intrinsic motivation

DEVELOPMENT OF A "SYSTEMS THINKING" COMPONENT FOR FIRST YEAR ORGANIC CHEMISTRY

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Abstract

This paper reports on the development of teaching materials to introduce systems thinking in organic chemistry. Systems thinking prepares chemists to think holistically and systematically about chemistry and its interconnectedness with many other disciplines. It is a response to the call for chemistry education to address the needs of society, and prepare graduates to tackle global challenges and contribute to sustainable development. We have chosen Aspirin as a signature pharmaceutical for this purpose. Several steps in the manufacturing sequence for Aspirin are highly energy intensive, but catalysts improve the efficiency of conversions, CO_2 is fixed in one of the steps and acetone is formed as a useful by product. Aspirin-derived compounds excreted by the body are biodegraded to endogenous biochemical metabolites. The first system-oriented concept map extension (SOCME) on Aspirin will be presented to depict

the interconnection between chemical, engineering, environmental and biological factors associated with its manufacture and use.

Keywords: Systems thinking, Aspirin production, SOCMEs, learning objectives

LEARNER-LEARNER TALK: A TEACHING METHOD TO ENHANCE LEARNING OF SCIENCE

N K Radebe & E Mushayikwa
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Abstract

The purpose of the study was to investigate the nature of learner-learner talk and its effectiveness in helping learners to solve conceptual problems in the Physical Sciences classroom. Using constructivist principles, the case study deconstructed learner-learner talk in the classroom to determine its effectiveness in assisting learners to solve conceptual problems in electromagnetism. Grade 11 learners in a high-density suburb in South Africa participated in the study. The learners were given group tasks during the lessons, and were audio recorded during their natural conversations in group work while trying to find solutions to the tasks. The audio recordings were then transcribed and analysed using Mercer's (1995) three types of talk. Analysis of the transcripts indicated that learners tended to engage more with cumulative talk, which is non-confrontational or critical, but seeks to add on or collaborate what previous speakers have said. Exploratory talk was used to a lesser extent, whereby learners introduced new ideas into the discussion. The Findings suggest that we should pay more attention at developing skills for exploratory talk as these skills enable learners to be critical and guided by evidence during decision making.

ANALYSIS OF LESOTHO SECONDARY SCIENCE TEACHERS' SELF-EFFICACY IN THE USE OF DIGITAL VIDEOS IN TEACHING

Tebello M Rangoanana & Tsepo Mokuku
National University of Lesotho

Abstract

The study investigated science teachers' self-efficacy towards the use of digital videos in teaching, guided by social cognitive theory. A case study design was employed, based on purposively selected high school science teachers from three schools in Lesotho. A questionnaire based on Computer Technology Integration (CTI) was administered to 16 science teachers followed by individual face-to-face open-ended interviews with seven teachers. Data were analysed qualitatively and the findings show that teachers' self-efficacy in digital audio-visual is influenced by environmental and technical factors. It is concluded that teachers who recently completed their training from institutions of higher learning are more confident than

their counterparts in the use of computers, and hence more inclined to incorporate the use of videos to enhance science teaching and learning.

Keywords: Teachers self-efficacy, confidence, digital videos, enhance teaching, quality teaching and learning

POST GRADUATE CERTIFICATE IN EDUCATION STUDENTS' TOPIC SPECIFIC PEDAGOGICAL KNOWLEDGE ON PARTICULATE NATURE OF MATTER

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University of KwaZulu-Natal[1] & University of the Witwatersrand[2]

Abstract

The purpose of the study was to investigate the development of pre-service natural science teachers Topic-Specific Pedagogical Content Knowledge (TSPCK) regarding particulate nature of matter. There were 97 pre-service natural science teachers enrolled in a methods course who participated in this study. Data were collected using validated instruments for TSPCK before and after teaching practice. Results indicated that participants' TSPCK improved at different levels after teaching the topic on the particulate nature of matter during teaching practice. The findings showed significant improvement with respects the knowledge of the curriculum (CS3) and representation of content (REP1). The findings of the study have implications for teacher education programmes.

Keywords: particulate nature of matter, topic specific pedagogical content knowledge pre-service teachers

IMPROVING TEACHING QUALITY THROUGH PROFESSIONAL LEARNING COMMUNITIES (PLC)

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Abstract

Professional Learning communities (PLC) for Physical Science teachers can be effective in ensuring the promotion of school and system-wide capacity building for sustainable improvement of teachers' content and pedagogical content knowledge. Coherence in teacher development through PLC meetings can be increased by incorporating experiences that are consistent with teachers' goals, aligned with state standards and assessments, and encourage continuing professional communication among teachers. The facilitative theory was used to establish roles of Physical Science subject advisors at PLC meetings. Qualitative data was collected through observations at PLC meetings and group interviews. Four PLC meetings were sampled in 4 districts in the Tshwane Education District-Gauteng province. Findings

indicated that teachers and subject advisors appreciate the impact of PLC meetings in assisting each other to improve and share content and pedagogical content knowledge.

THE EFFICACY OF USE OF THE UNIT FACTOR METHOD AT A PROFESSIONAL DEVELOPMENT WORKSHOP TO PROMOTE TEACHERS' USE OF PROPORTION IN SOLVING REACTION BASED STOICHIOMETRY QUESTIONS

Angela Stott
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Abstract

South African physical sciences (SA PS) teachers are known to have difficulty with proportion, including within stoichiometry. This quantitative survey study investigated the efficacy of a two-day stoichiometry professional development workshop which introduced attendees to the unit factor method for proportion. The prevalence, method choice, and correctness of use of proportion, were analysed for 171 SA PS teachers' answers to four calculation questions in each of a pre- and a post- test written at the start and end, respectively, of the workshop. The pre-test data reveals that 21% of the teachers did not display any correct use of proportion, 62% avoided proportion for the more complex questions, and only one teacher made use of the unit factor method. The post-test data is currently being analysed, after which claims can be made regarding the efficacy of the professional development workshop at improving proportion usage in stoichiometry.

THE INQUIRY-BASED PRACTICAL WORK PCK OF PRIMARY PRESERVICE SCIENCE TEACHERS IN LESOTHO AND ZIMBABWE

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Abstract

In this study, the self-reported inquiry-based practical work (IBPW) pedagogical content knowledge (PCK) of preservice primary science teachers from Lesotho and Zimbabwe was explored through a specially designed open-ended reflection questionnaire. Basing on a qualitative, exploratory and comparative study approach, fifteen preservice teachers from each of the two primary teacher-training colleges from the two countries were purposely selected for having completed teaching practice in multiple-deprived classrooms. A PCK for science teaching that used a topic-specific focus on IBPW was used as a conceptual framework. Directed content analysis and constant comparison techniques were used to analyse data. The findings indicate that the preservice teachers developed PCK that was influenced by the multiple-deprived conditions that characterised the classrooms they taught in during teaching practice. The preservice teachers' knowledge of contextual factors and learner populations influenced their choice of IBPW activities, instructional strategies and assessments to be implemented in the classrooms.

Keywords: inquiry-based practical work; multiple-deprived classrooms; pedagogical content knowledge; preservice science teachers

THE CONCEPTUALIZATION OF DIGITAL-TOPIC SPECIFIC PEDAGOGICAL CONTENT KNOWLEDGE

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Abstract

One of the visible impacts of the covid-19 pandemic on education has been the unprecedented accelerated swing towards online teaching and learning. The observed shift has illuminated the glaring gaps for theoretical frameworks that help teachers move their well-established traditional pedagogies to online platforms. In Science Education, Pedagogical Content Knowledge (PCK), specifically Topic Specific PCK has demonstrated its value in enabling the development of sound and pedagogically reasoned lessons. This paper argues for the need of a new conceptual framework, namely digital-TSPCK (d-TSPCK), enabling teachers to develop and deliver seasoned science lessons in a format suitable for online lessons with greater control. Building on the existing conceptual frameworks of TSPCK and TPACK, this paper presents a systematic development for a conceptual argument defining d-TSPCK. This is an important initial step towards defining d-TSPCK

ENACTED TOPIC SPECIFIC PEDAGOGICAL CONTENT KNOWLEDGE: A CASE OF RURAL OUT OF FIELD NATURAL SCIENCE TEACHERS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

Nonkanyiso Vokwana, Marissa Rollnick & Elizabeth Mavhunga
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Abstract

About 39% of science teachers in South Africa are teaching "out of field" (OOF) of their expertise of training which causes challenges such as poor content knowledge and lack of confidence in the content they are teaching. To improve the enacted Pedagogical Content Knowledge (ePCK) in the particulate nature of matter, fifteen OOF teachers were exposed to a Professional Development Intervention (PDI) using TSPCK. A subset of three teachers were followed to their classrooms to investigate the quality of TSPCK in their classroom teaching on the particulate nature of matter before and after their exposure to PDI. Data was collected through video-recorded lessons followed by in-depth qualitative analysis for TSPCK episodes. The identified TSPCK episodes were matched with the categories of quality in the eTSPCK rubric. The findings of the study revealed positive shifts in the quality of teachers' eTSPCK post the intervention compared to their eTSPCK before the intervention.

Keywords: Out of field; eTSPCK, Professional Development Intervention

SCIENCE SNAPSHOT PAPERS

TECHNOLOGICAL ADAPTATIONS SHAPING ENACTED PCK OF IN-SERVICE SCIENCE TEACHERS: BLENDED LEARNING APPROACH

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Abstract

The use of information and communication technology in education is now more relevant with the recent Corona virus pandemic which has obliged most schools to adopt blended teaching. This emerging pedagogy require teachers to adapt their pedagogical content knowledge. Our qualitative research seeks to examine the experiences of in-service science teachers as they adapt their PCK in the use of ICT tools in teaching of particulate nature of matter. Data will be collected from four in-service science teachers from two high schools around Johannesburg, through lesson plans, journal entries reflections of lessons and videotaped lessons and interviews conducted after the lesson and will be analysed deductively. It is expected that findings will reveal how the teachers' experiences integrated ICT tools such as laptop, interactive whiteboards, videoclips from YouTube, educational games in face-to-face and online learning platforms to explain and demonstrate scientific phenomena and concepts in lesson design, enactment and reflections.

GAZING INTO INSTRUCTIONAL PRACTICES OF INTEGRATED NATURAL SCIENCES AND TECHNOLOGY TEACHERS IN THE INTERMEDIATE PHASE

B P Mabaso & S H Ngema
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Abstract

Instructional practices to teaching integrated natural science and technology in the intermediate phase persist in being a challenge in many school settings. This paper reports a study exploring intermediate phase teachers' instructional practices of the integrated Natural Sciences & Technology Curriculum. To understand teachers' instructional practices, the proposed study will employ a case study approach to collect qualitative data from teachers of Umlazi district primary schools. Through the use of questionnaires, observations, and interviews, six teachers will be purposively selected. Preliminary findings imply that past teaching experience and qualification specialisation or a lack thereof off, impacts on how and the degree to which

natural sciences is integrated with technology education. It, therefore, indicates that intermediate phase teachers do need some professional developmental training on how to teach the integrated curriculum to equip learners with scientific and technological literacy.

Keywords: instructional practices, integration of Natural Science and Technology, PCK, Intermediate Phase.

EXPLORING CHALLENGES AND OPPORTUNITIES OF PHYSICAL SCIENCE EDUCATORS` USE OF BLENDED LEARNING IN A RURAL SETTING

A Mudau & T E Nkanyani
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Abstract

The expectations, through the reform of our education system required teachers to transform their teaching approach in order to favour learner centredness. The emergence of the Fourth Industrial Revolution further amplified the expectations. Teachers are expected to keep to pace with current technological developments. Research however indicates challenges in the implementation of technology in Schools whereas at the same time there are some experienced teachers who indicate their discomforts in ICT. There are a number of ICT methods that are employed in class, however blended learning proves to be one of the choices. More studies on blended learning in the higher education sector were done, but fewer were done pertaining to basic education setting. The current study however intends to investigate the experiences of science educators in the implementation of blended learning in their teaching, with focus on challenges and opportunities.

DEVELOPING THE TSHIVENDA SCIENTIFIC REGISTER AND ITS INFLUENCE ON THE TEACHING AND LEARNING OF PHYSICAL SCIENCES

N P Netshivhumbe & AV Mudau
University of South Africa

Abstract

The purpose of this study is to develop Tshivenda scientific register for physical science teaching and learning. Classroom Language Investigative Framework (CLIF) will be used as a conceptual framework for this study. The study will employ qualitative approach wherein teachers, circuit manager, curriculum advisor and SGB of selected schools will participate in the study. The following research questions will be explored: what are the challenges and opportunities in the development and use of the Tshivenda scientific register for the teaching of physical science? How does the use of Tshivenda language in the teaching and learning of physical science influence meaningful learning and performance? What are the attitudes and

views of physical science teachers and learners towards Tshivenda as medium of instruction? Classroom observation, interviews and questionnaire will be used to collect data.

Keywords: Challenges, Development, Medium of instruction, Physical Sciences, Scientific register, Teacher.

DEVELOPING THE SCIENTIFIC LANGUAGE REGISTER FOR NATURAL SCIENCES IN ISINDEBELE AND ITS APPLICATION IN SOME CLASSES IN THE SIYABUSWA 2 CIRCUIT

T G Ntuli & A V Mudau
University of South Africa

Abstract

The purpose of this study is to develop the scientific language register for Natural Sciences in IsiNdebele and its application in some classes in the Siyabuswa 2 circuit. Since the use of indigenous languages in education has become a pertinent issue in South Africa. Introducing indigenous languages as medium of instruction in South African schools wherein learners will be taught and learn in their mother tongue is one of the is one the Department of Education's visions. However, that vision will not be realised if there are no adequate resources such as language teachers, teaching and learning materials offered in indigenous languages. The above factors made the researcher realise the significance of conducting this study. Consequently, this study is aimed at developing the scientific language register for Natural Sciences in IsiNdebele and its application. The study will follow both qualitative and quantitative approach.

Keywords: Indigenous languages, Scientific language register and isiNdebele.

THE USE OF PADLET TOOL TO IMPROVE LEARNING OUTCOMES AMONG SECONDARY SCHOOL BIOLOGY LEARNERS: AN EXPERIMENTAL STUDY TOWARDS A SHIFT IN PEDAGOGY

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Abstract

Biology is a very critical elective subject which is learnt at the Senior High School level in Ghana to prepare learners for future careers that are biology-related. However, most biology teachers do not employ web-based tools to enhance their teaching and to improve learners' learning outcomes. This study, therefore, seeks to investigate the implementation of Padlet in the elective biology classroom to teach key biological concepts and further report on the impact of this pedagogical tool on learners' engagement and learning outcomes. The study employed a mixed-methods research design to augment both qualitative and quantitative data collection and triangulation. Four schools were purposely selected to take part in the study. Four teachers were trained to implement the Padlet tool in their biology classrooms. Data were collected

using classroom observation, questionnaires, interviews and documentary reviews. Data will be analysed quantitatively (using SPSS) and qualitatively (using Thematic content analysis framework).

Keywords: Assessment for Learning, Collaborative Learning, Elective biology, Learners, Padlet, Teachers,

BLENDING ONLINE HOMEWORK AND LARGE CLASS TUTORIALS TO PROVIDE LEARNING SUPPORT FOR INTRODUCTORY ORGANIC CHEMISTRY

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Abstract

This paper describes a case study that was conducted on the introduction of blended learning in first year organic chemistry. Increasing student numbers in first year at the University of Pretoria meant that students could only be accommodated in a face-to-face tutorial every second week and online tutorials in alternate weeks. We implemented blended learning using a cross-over course design. This course design provided an opportunity to explore the associations between tutorial modality (F2F or OL), and student performance for each topic in the organic chemistry syllabus for the whole group and poorly performing students. Our results suggest that, in general, students gain more from face-to-face tutorials than online homework.

EFFECTIVE LEARNING STRATEGIES FOR A FIRST-YEAR BLENDED CHEMISTRY COURSE

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University of Pretoria, South Africa

Abstract

High dropout rates in higher education institutions combined with low participation rates are problematic. Several factors have been identified as the major contributors to the high dropout rates experienced such as affordability, lack of academic support, lack of career guidance, lack of self-discipline and commitment. This study aims to identify effective learning strategies that students may implement to better self-regulate their own learning in a chemistry course to increase prospects of success. The study will follow a quantitative approach. Motivated Strategies for Learning Questionnaire (MSLQ) and Online Self-regulated Learning Questionnaire (OSLQ) will be utilised for data collection. Statistical Package for the Social Sciences (SPSS) will be used for data analysis. An understanding of effective learning strategies for chemistry can be used to advise students and hence contribute to the mitigation of the high dropout rates.

DEVELOPING AND APPLICATION OF A XITSONGA PHYSICAL SCIENCE SCIENTIFIC REGISTER FOR XITSONGA HOME LANGUAGE TEACHERS AND LEARNERS

V J Ramashia & A V Mudau
University of South Africa

Abstract

The purpose of the study is to explore the extent at which the use of Xitsonga as a Language of teaching and learning shape teaching and learning of physical science. This study will be a qualitative interpretive study that will involve three participants who will teach states of matter and the kinetic molecular theory in grade 10 South African curriculum using Xitsonga as a language of learning and teaching. The study will be conducted in the Hlanganani North Circuit of Vhembe district in Limpopo province, South Africa. Ethical consideration will be observed in this study such using pseudonyms to protect the identities of the participants.

EXPLORING THE CHALLENGES AND OPPORTUNITIES IN THE TEACHING OF PHYSICAL SCIENCES DURING THE FOURTH INDUSTRIAL REVOLUTION

O F Sadare
University of South Africa

Abstract

Technological innovation enables new forms of autonomous learning and transforms the traditional teaching methods. The Fourth Industrial Revolution (4IR) is a technological advancement predicated upon the third Industrial Revolution (3IR) that resulted into the convergence of physical, digital and biological innovations. Studies have shown the competency required for the implementation of 4IR. The teaching of physical sciences with the 4IR will enable the learners to have adequate skills to succeed academically. The study seeks to explore the challenges and opportunities in the teaching of physical sciences during the fourth industrial revolution. A qualitative approach will be used to collect data by means of interviews with teachers and classroom observations. It is hoped that 4IR integration will enable more resourcefulness on the part of teachers towards improvement in teaching quality and better performance of physical science learners.

Keywords: Fourth industrial revolution, Physical sciences

THE DEVELOPMENT AND IMPLEMENTATION OF THE SUSTAINABLE INTERVENTION STRATEGIES FOR SOLID WASTE MANAGEMENT IN PRIMARY SCHOOLS: A CASE OF NKANGALA DISTRICT, MPUMALANGA PROVINCE

L Sikhosana & AV Mudau
University of South Africa

Abstract

This is a qualitative interpretative multiple case study design embedded within social constructivism theoretical framework. The interests of the study are based on anecdotal evidence, the researcher observed that some of the schools are polluted with solid waste and there are no (or minimal) waste management initiatives that are implemented to manage waste effectively. The aim of the study is to develop and implement sustainable intervention strategies for solid waste management in schools in Nkangala District, Mpumalanga province.

Three intermediate schools will be purposefully sampled. Participants will be learners, teachers, school principals, general workers and school governing body members. Qualitative data will be collected through semi-structured interviews, focus group interviews, observations, diary and open-ended questionnaires. Data will be analysed using typology approach based on research questions, categories and themes, theoretical and conceptual framework. This is not a comparative study, all data collected will be analysed as a single case.

INVESTIGATING THE EFFECTIVENESS OF TEACHING METHODS USED IN TEACHING MAGNETISM IN A FIRST YEAR BEd SP/FET PHYSICAL SCIENCES COURSE

B van der Westhuizen, S Gewensa, Z Matshoba & J Zibia
University of the Witwatersrand

Abstract

Literature shows that deciding on an effective teaching method is confusing, even in the best education systems. The challenge lies in aligning the teaching method with the learners' needs and not to personal preference. In South Africa the challenge does not only lie there, but also in the failure of the system to support teaching of student teachers to teach students in the context of the fourth industrial revolution.

The goal of this study is to investigate the effectiveness of the current teaching methods in a BEd program course by comparing the level of cognitive understanding of magnetism before and after it has been taught.

CREATIVITY & PCK IN ELEMENTARY PRESERVICE TEACHERS

William R Veal
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Abstract

The purpose of this snapshot presentation is to present the ongoing research project that will find relations among pedagogical content knowledge (PCK) attributes and creativity variables. Good to great science teachers are considered to have PCK. In many instances, creative teachers are also considered good to great. This study focuses on a moment in time that describes 62 elementary preservice teachers' PCK and creativity in a science methods course during their penultimate semester in teacher training. The elementary preservice teachers completed a science lesson plan, wrote a narrative explaining why they included certain aspects of the lesson plan, answered 10 questions on a science teacher accreditation exam, and completed a Torrance test of creativity. These data points will be used to examine any relationships among PCK attributes and creativity variables.

TRANSLATION OF SCIENCE PRE-SERVICE TEACHERS' PCK FROM ONE PCK REALM TO ANOTHER IN AN ONLINE TEACHING AND LEARNING ENVIRONMENT

M F Zondi
University of the Witwatersrand, South Africa

Abstract

This study is at the inception stage thus ideal for a round table discussion. It seeks to examine the translation of science pre-service teachers' PCK from one realm into another in an online teaching environment. Existing and emerging knowledge about the role of teacher reflection as one of the influential elements in effecting the translation of the teachers' TSPCK across the different realms of PCK will be key. While the study is grounded on the broader theoretical framework of PCK, it draws on the conceptual frameworks of traditional TSPCK and digital-TSPCK. An intervention based qualitative research design in a case study of thirty (30) pre-service teachers targeting the development of teaching videos in Chemical Equilibrium is planned. Teacher reflections and other factors influencing the preservice teachers' TSPCK as they move from planning, into developing the teaching videos and ultimately into the delivery as displayed in the video will be examined.

SCIENCE POSTER PAPERS

FROM COMPLIANCE TO INTEGRATION: MICROSCIENCE ENABLES LEARNING THROUGH PRACTICAL ACTIVITIES

S Khulu, O Akinyemi, J Bradley & E Mavhunga
University of the Witwatersrand, South Africa

Abstract

University courses preparing students to teach school science should be models of good practice rather than reflections of accepted behaviour in schools. At the same time, the requirements of the national school curriculum and the real difficulties faced by teachers must be catered for. This work reports on the revision of the chemistry component for the final fourth-year Physical Science student teachers. The revision is continuing, being informed by experiences so far and is aimed at addressing the difficulties faced by teachers. Extensive adoption of microscale activities enabled greater student access to hands-on, minds-on experiences, whilst improving safety and reducing environmental impact.

TECHNOLOGY LONG PAPERS

CHANGES IN IT AND CAT ENROLMENT AND PERFORMANCE ACROSS SOUTH AFRICAN SCHOOL TYPES

Angela Stott
University of the Free State South Campus, South Africa

Abstract
Information technology (IT) and Computer application technology (CAT) have the potential to help bridge the digital divide associated with South African socioeconomic differences. However, the nature of enrolment and performance, across the school quintiles, for these subjects, is under-researched. In this study, the 2010-2019 matric Free State Province enrolment- and performance- data for IT and CAT, downloaded from the EMIS database, were analysed. This revealed very low enrolment in IT, particularly at lower quintile schools, with much attrition in high-, and some uptake in low- quintile schools, across the decade. CAT enrolment was found to be considerably higher in higher quintile, independent and special needs, than in low quintile, schools, and decreased across the decade in schools of all five quintiles, with a particularly pronounced decrease in low quintile schools. Performance in both subjects differed predictably across the quintiles. For both CAT and IT, performance was high and stable across the decade for quintile 5 schools. For lower quintile schools, performance was erratic across the decade for IT and tended to show improvement to 2013, decline, then improvement to 2019, for CAT. Explanations for the observed trends are proposed in terms of the Theory of Planned Behaviour. These include speculations that implementation of the Progression Law in grades 10-12 decreased already low perceptions of behavioural control and subjective norms regarding CAT in low quintile schools, contributing to CAT attrition since 2015. Interest groups are identified for further qualitative research aimed at decreasing the digital divide.
Keywords: Digital divide, Information and communication technologies (ICTs), E-education, digital literacy, poverty

STUDENTS' PERCEPTIONS OF E-ASSESSMENT IN THE CONTEXT OF COVID-19: THE CASE OF UNISA

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Abstract
The purpose of this study was answering the question: What are Information and Communication Technology (ICT) students' perceptions of e-assessment? Its importance is justified regarding positioning these students' education towards the development agenda in

Southern Africa despite disruptions. It draws on the latest relevant findings on ICT programming teaching and learning and is located within relevant conceptual/theoretical frameworks on assessment. In quantitative aspects of the design, issues of reliability and validity were considered, while in qualitative aspects, issues of dependability and interpretation were important. Results presented are encouraging: e-assessment enhanced quality aspects of students' learning, and helped to improve the quality of assessment in higher education. Discussion of the results shows insight and originality by suggesting implications and making recommendations that are applicable and useful. In conclusion and answer to the research question, students' perceptions of e-assessment were positive, valuing features regarding e-assessment providing faculty with feedback to improve learning.

TECHNOLOGY SHORT PAPERS

EXPLORING THE TRANSITION FROM BLENDED TEACHING TO EMERGENCY REMOTE TEACHING IN THE WAKE OF THE COVID-19 PANDEMIC: TEACHER EDUCATORS' EXPERIENCES

Portia Kavai
University of the Witwatersrand, South Africa

Abstract
"All contact teaching and University activities involving face to face interaction are postponed, including tests as the university takes an early recess in response to the Covid-19 pandemic……." This type of communication and many others that followed were all related to the measures which would slow down and/or minimize the spread of the Covid-19 infections across educational institutions worldwide including South African universities and schools. One of these measures was to adopt remote teaching and learning using a variety of online digital technologies.
This case study explored the experiences of the teacher educators as they transitioned from the traditional face to face and blended teaching to emergency remote teaching (ERT) mode. A purposive sample of 4 teacher educators at a South African University participated in the study. The preliminary analysis of the results showed that this emergency transition unveiled some gaps in terms of the skill level, preparedness and resources needed to migrate to Emergency Remote Teaching.

Keywords: COVID-19, digital learning, teacher educator, emergency remote teaching, transition

COLLABORATING ON ICT INTEGRATION IN BASIC EDUCATION. THE CASE OF A TEACHER IN LESOTHO

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Abstract
As technology continues to evolve, more opportunities for classroom instruction using Information Communication Technology (ICT) emerge. Moreover, some teachers are also trained professionally in ICT pedagogy. However, the training does not benefit most schools in Basic Education in Lesotho, as teachers encounter challenges within the school context. Regardless of the challenges, there are teachers in Lesotho who are passionate about ICT integration. This qualitative case study paper intends to reveal, through the lens of social constructivism and knowledge building, how a teacher collaborates with colleagues locally and

globally. The teacher has purposively been selected for the study. Findings indicate that, regardless of challenges, when teachers support one another, there are several possibilities of ICT integration, even at highly challenged schools, as many teachers and learners have mobile phones. The study recommends that self-driven teachers should be recognised and supported with a basic ICT infrastructure to assist them in collaborating with more teachers.

Key words: ICT integration; knowledge building; social constructivism; collaboration

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