NMMU ENGAGEMENT EXCELLENCE AWARD APPLICATION TEMPLATE

1. **Name of Applicant:** Paul Webb

2. **Names of Team Members:**

3. **Indicate the Award Category being applied for**

3.1.	NMMU Engagement Excellence Award	X
3.2.	NMMU Engagement Excellence Team Award	
3.3.	NMMU Emerging Engagement Award	

4. **Nature of the engagement activity/project**

The scientific literacy project was initially launched in 2008 with financial support from the DG Murray Trust (R200000 per annum). After initial developments the project enhanced its research focus with the support of a South Africa-Sweden Links Project funded by the NRF and the Swedish Vetenskapradet (R150000 per annum). Thereafter the dissemination of the project to a wider audience of schools, teachers and learners was facilitated as part of The DG Murray Integrated Schools Project (R1.3M per annum) which ran from 2010 to 2012. I led all of these projects from inception to completion. The focus of this report is on the results of the Scientific Literacy activities as an example of an excellent engagement project within the NMMU's conceptions of academic engagement.

The scientific literacy development project had both a research and development strategy which aimed to improve science education in schools and produce generalizable findings to inform science education nationally and internationally. The rationale for developing the strategy was that, although scientific investigations are an important core aspect of the science curriculum, authentic investigations are seldom carried out in South African schools. As such, the comprehensive strategy to improve science teaching and learning in their schools included the following:

- Development of an engagement intervention;
- Engagement with teachers and schools to develop literacy practices in the content area of science;
- Share the ideas and pedagogical practices with teachers and embed the strategy in their teaching; and
- Research and refine the outcomes.

The development of the engagement intervention required the production of appropriate instructional materials, as well as a sound professional development programme for teachers. The science reading material for learners centred on prompting discussion and exploratory talk in the classroom (see appendix J). This type of talk allows children, with guidance, to design investigable experiments. Teacher resources and materials included the provision of 'keystone' apparatus as exemplars to enable authentic scientific investigations in classrooms, plus a strategy for teachers to get their learners to record, report and evaluate their findings in a

scientifically acceptable way. In light of the successful development of materials and positive feedback from teacher participants, a Short Learning Programme (SLP) to promote Scientific Literacy was developed in 2009. (Appendix C).

The strategy was developed over a number of years and personnel from national NGOs such as the Primary Science Programme (Western Cape), the Mathematics Centre for Professional Teachers (MCPT) and the READ organisation provided initial large scale testing situations. Implementation and research were also carried out in rural schools near Alice, and more locally in 40 schools in the Port Elizabeth and Uitenhage districts over the past three years. The main partners during this period were the Port Elizabeth and Uitenhage Education District Offices, the DG Murray Trust, and the NRF.

As such, all four four engagement categories provide the framework for these activities, namely Community Service and Outreach, Engagement through Professional/Discipline-Based Service, Engagement through Teaching and Learning, Engagement through Research and Scholarship.

5. Assessment Criteria

5.1. Criteria 1

The impact and significance of the engagement activity

The Scientific Literacy intervention, once initially researched and conceptualized, was piloted as workshops with working groups of personnel from the Primary Science Programme (Western Cape), the Mathematics Centre for Professional Teachers (Johannesburg) and the READ organization (Johannesburg). The strategy was also tested in seven schools in the Tyumie Valley near Alice during 2007. Once the findings of these pilot interventions the strategy was employed in six experimental (and four control) township schools in Port Elizabeth in 2008. The strategy was adopted by the READ organization and 20 READ field workers were trained. These fieldworkers worked in 30 schools in each of seven provinces of the country (the Northern Cape and Gauteng being the exceptions).

Thereafter the Scientific Literacy strategy was embedded in the approach of nearly 100 teachers in 40 schools in the Port Elizabeth/Uitenhage Educational Districts. (Appendix D). The programme was offered as a Short Learning Programme (SLP) with on-going classroom support as a component of the DG Murray Trust funded Integrated School Improvement Programme. It was also offered at Bayworld by four accredited museum school staff members in a format designed to accommodate selected visiting school groups. These schools had to commit to an on-going series of visits to the museum during the course of a year. The SLP was also offered at the request (and funded by) the GM Foundation to teachers in 13 selected Northern Areas and township primary schools in 2012. This intervention was aimed at increasing these schools participation in the Eastern Cape Science Exposition (none had ever participated previously). After participation in the SLP these schools entered 13 Projects in the Exposition, of which 12 were awarded medals (nine bronze, two silver, and one gold). The submission which received a gold medal was invited to participate in the National Olympiad in Johannesburg where the project was awarded a bronze medal.

Research has revealed that not only has the intervention impacted on teacher practice in the classroom, but has also improved learner achievement in science, language abilities in both the language of instruction and mother tongue, as well as the participating children's' problem solving abilities. The intervention has operated in our local African context by researching language and learning and disciplinary literacies in science education, particularly when learning takes place in a second-language. The research that was carried out in terms of argumentation, authentic

discussion, writing heuristics, conceptual change, etc. has also provided points of embarkation for the generation of cutting edge knowledge emanating from the NMMU (see publications in Appendix A). As the Scientific Literacy activities fell under the general umbrella of the Integrated Schools Improvement Project and the IT in Schools Project which I conceptualised, executed and managed, and which both fed into and from the Scientific Literacy project, I have also included the scholarly outputs from these projects.

The Scientific Literacy activities have contributed to the NMMU's vision of being a dynamic African university, recognized for its leadership in generating cutting-edge knowledge for a sustainable future, and its mission to offer a diverse range of quality educational opportunities that will make a critical and constructive contribution to regional, national and global sustainability. The Scientific Literacy activities have also contributed to the university's strategic objective of nurturing, developing and retaining research potential and talent, and of providing support to emerging researchers to become research active in the field. This aspect is evidenced by the fact that during the life of the project, three master's degrees by research and four doctoral theses on the topic were produced since 2010 (see appendix B). In the same period four journal articles and six conference proceedings (one a keynote address at IOSTE) were produced, as well as four unpublished conference presentations (see appendix B). Apart from the promotion of increased enrolment of postgraduate students the strategy has provided a vehicle for promoting improved staff qualification profiles as all four of the PhD studies were undertaken by NMMU academic staff members, as was the case for one of the master's degrees.

5.2. Criteria 2

The intellectual endeavours contributed by the engagement activity.

The knowledge and skills which were developed have been applied in terms of large scale (300+ teachers) development exercises which produced measured and monitored improved teacher practice in the classroom thereafter. The intellectual findings have been integrated into the science education modules offered to intermediate phase teacher education students in the Faculty of Education at the NMMU. The contribution to the body of knowledge is reflected by the journal articles and the postgraduate degrees earned (see appendices A and B). The article in *Science* was requested by the journal editor, which is evidence of the level of contribution to the body of knowledge. Solicitation and acceptance of this article also attests to the level of creativity and innovation inherent in the strategy.

In a more local context, the strategy is innovative and creative in that it confronts the ingrained authoritarian teaching practices which still exist as a result of the effects of Fundamental Pedagogics and National Christian Education which was enforced by the pre-1995 Nationalist government of South Africa.

In all instances the strategy was implemented in cooperation at many levels within the National and Provincial Education Departments with which we worked. All research was couched within the principles and approval of NMMU Research Ethics Committee and premised on informed consent by all participants.

5.3. Criteria 3

Communication and dissemination of knowledge and expertise

The finding of the project was represented and communicated at a number of levels. These included feedback to teachers and principals via reports and celebratory functions (which included the awarding of SLP certificates). Regular reports have been submitted to funders (Appendix E); mainly to the DG Murray Trust within the terms of agreement for funding the initial research and development aspects of the strategy; the NRF and Swedish Navorsingsradet on research aspects of the project; and again to the DG Murray Trust as part of the biannual reporting procedure required by the Integrated School Improvement Project agreement. Verbal reports and presentations have also been made to the DG Murray Trust and other partner organisations.

On reflection, the process has been successful on a number of levels. In terms of the funders the continued support of the DG Murray Trust over six years appears to attest to their belief in what we have attempted to do. Similarly, extension of the Sweden-South Africa Scientific Literacy research project (Appendix F) by the NRF suggests approval. The successful completion of research master's and doctoral degrees, and the ensuing publications from theses, dissertation and independent research activities on the project also indicate successful integration of research and engagement, as has the integration of the strategy into mainstream science education at the NMMU and invitations to be a keynote speaker at international conferences. The SLP on promoting scientific literacy has been acknowledged as 'best practice' by colleagues in the Faculty of Education and has provided a blueprint and benchmark for other SLPs such as a similar Faculty of Education SLPs in mathematical reasoning and mechanics. Five academic staff members registered for the scientific literacy SLP in order to be accredited as facilitators, as did two principals of schools and two independent consultants, all of whom are available to conduct training in the scientific literacy strategy.

5.4. Criteria 4

The strategic importance of the role performed by the individual/team

I have been responsible for the conceptualization, development, enactment and research carried out under the auspices of the scientific literacy strategy. Implementation of the strategy has been a team effort involving primarily Dr Mary-Grace Villanueva, Dr Jeff Ilsley (both academic staff members) and Mr Viv England (consultant), as well as with department of education officials in terms of logistics. Leadership and management of the project, intellectually, administratively and financially has been my responsibility.

As noted earlier, the project has partnered nationally with the READ organization, the Primary Science Programme (Western Cape), the Mathematics Centre for Professional Teachers (MCPT) in Gauteng; with the National and a number of provincial departments of education; and the DG Murray Trust and the NRF. International co-operation has included the Swedish Navorsingsradet and colleagues from Gothenburg and Uppsala University in Sweden (Appendix G).

5.5. Criteria 5

The extent to which the engagement activities are acknowledged/recognized

The value of the engagement activities have been attested to by the on-going good relationships with the Port Elizabeth and Uitenhage District Offices, the on-going support financial support from

the DG Murray Trust, invitation as a keynote speaker at the Gothenburg University 'Literacy Without Borders' conference (Appendix F) and the biennial IOSTE conference in Tunis, as well as the papers accepted for publication by international and South African journals.

The 'buy-in' by academic staff in terms of premising their postgraduate studies on the strategy (Appendix H) (Mary Grace Villanueva, Lyn Webb, Percy Sepeng and Sam Leonard), their participation in the Scientific Literacy SLP to enable them to train teachers in the use of the strategy (Jeff Ilsley, Elsa Lombard, Helena Oosthuizen, Percy Sepeng, Brian Walters,Raj Kurup , and Mary-Alice Barksdale – Fulbright from Virginia Tech), and incorporation of the strategy in mainstream teaching (Mary Grace Villanueva and Jeff Ilsley) are evidence of recognition by internal stakeholders

5.6. Criteria 6

The integration of engagement into the core academic functions

As noted above the strategy has been incorporated in the PICN modules for intermediate Phase Teacher Education students and within a number of postgraduate projects and research activities (see appendices A and B)

5.7. Criteria 7

In the case of engagement through research and scholarship, the information referred to under Assessment Criteria (Criteria 7), where applicable needs to be provided.

The scientific literacy strategy developed at the Nelson Mandela Metropolitan University (NMMU) aimed at producing a documented and replicable teacher development strategy plus the supporting material (Appendix I) and apparatus to enable teachers to meet the outcomes of the national curriculum in terms of science education. The rationale for developing a strategy is that although scientific investigations are an important core aspect of the science curriculum, authentic investigations are seldom carried out in South African schools. An authentic scientific investigation is a practical activity for which detailed instructions are not given and in which the learner does not know the result before the investigation. However, the reality is that in the few schools where practical work is done at all, it most often takes the form a pre-determined experiment that simply verifies a scientific principle or concept that is already known and does not challenge learners to develop higher order thinking and process skills.

Research has also shown that South African teachers appear unable to communicate attitudes of curiosity, respect for evidence, and critical reflection necessary for the development of higher-order cognitive skills. It has also been noted that in the early years of schooling, pupils' listening, speaking, reading and writing skills are poorly developed in both their first language and in English. As further progress at school depends on these basic literacy skills, black children, who generally come from disadvantaged homes, are further handicapped by the practices prevalent in their classrooms.

Other research has shown that due to the low level of language competence and cognitive skills in black schools, learners are unable to read school learning material and find difficulty in completing tasks and exercises they are given. This leads to a heavy reliance on rote learning

and makes the learners dependent on the teachers for everything they learn. All of the above issues premised the conceptualisation of the strategy.

The research questions were developed from the conceptualisations above and the research focused on whether the teachers were able to implement the strategy and, if so, what was the effect on the learners' conceptual knowledge, problem solving skills, general literacy skills, and discussion and argumentation abilities within a range of contexts encompassing science and mathematics education.

A mixed method, quasi-experimental design was used in most of the studies, but the degree to which quantitative or qualitative methods were employed depended on the context. Data were generated via classroom observations, teacher questionnaires and interviews, and learner artefacts (tests, written work, etc.)

Standard reports were prepared by the project leader as required and The results of the study were disseminated as journal articles, conference presentations and proceedings, formal reports and celebratory functions, and theses and dissertations. The scientific Literacy Strategy Project supported the Faculty of Education research theme 'Science, Mathematics and Technology Education' as well as the NMMU Institutional Research Theme 'Science, Mathematics and Technology Education for Society'.

6. Contacts

Provide the names and details of internal and external stakeholders/partners that can be contacted.

Ms Renita Affat, NMMU Trust. 041-5044586 renita.affat@nmmu.ac.za

Dr Mary Grace Villanueva, Faculty of Education, South Campus, 0722502492, marygrace.villanueva@nmmu.ac.za

Viv England, Consultant, 0833100795, england1@telkomsa.net

Prof Denise Zinn, Dean of Education, NMMU. denise.zinn@nmmu.ac.za

Mr Phillip Methula, Portfolio Manager, DG Murray Trust, 021 670 9840,

Mrs Xoliswa Selana, EDO, Uitenhage District Office, Department of Education. 082 0749 637 and xoliswa.selana@gmail.com

Dr Nyathi Ntsiko, Director, Port Elizabeth District Office, Department of Education. 0414034400 and Annietjie.Barnard@edu.ecprov.gov.za (secretary)

7. Attach a Portfolio of evidence and supporting documents linked to the above criteria

See appendices

8. Please confirm that all the information provided is correct by signing your application

Name: Paul Webb **Signature**: P. Webb

Appendix A

Journal articles

Sepeng, P., & Webb, P. (2012). Exploring mathematical discussion in word problem-solving. *Pythagoras, 33*(1), 1-8.

Webb, P. (2010). Science education and literacy: Imperatives for the developed and developing world. *Science,* 328(5977), 448 – 450.

Webb, P. & Mayaba, N. (2010). The effect of an integrated strategies approach to promoting scientific literacy on grade 6 and 7 learner's general literacy skills. *African Journal of Research in Mathematics, Science and Technology Education*, 14(3), 35-50.

Webb, P. (2009). Towards an integrated learning strategies approach to promoting scientific literacy in the South African context. *International Journal of Environmental and Science Education*, 4(3), 313-334.

Villanueva, MG. & Webb, P. (2008). Scientific investigations: The effect of the 'Science Notebooks' approach in Grade 6 classrooms in Port Elizabeth, South Africa. *African Journal of Research in Mathematics, Science and Technology Education*, 12(2), 5-18.

Webb, P., William's, Y. & Meiring, L. (2008). Concept cartoons and writing frames: Developing argumentation in South African science classrooms? *African Journal of Research in Mathematics, Science and Technology Education*, 12(1), 4-17.

Journal articles in press or submitted showing international cooperation

Webb, P., [1]Bach, F, Kurup, R. & Meiring, L. (submitted). Argument and discussion in science classes: For better or worse? *International Journal of Science Education,*

Mayaba, N, [2]Otterup, T. & Webb, P. (in press). Writing in science classrooms: A case study in South African and Swedish second-language classrooms. *African Journal of Research in Mathematics, Science and Technology Education,*

Drs Frank Bach[1] and Tore Otterup[2] are academics at the University of Gothenburg, Sweden

Conference proceedings

Webb, P. (2012). Promoting scientific literacy: what are the possibilities? *Science and Technology Education for Development, Citizenship and Social Justice.* IOSTE 15 Symposium, Hammamet, Tunisia, 19pp. (Keynote)

Webb, L; Webb, P, & Foster, L. (2011). Multilingual mathematics teachers' voices: conflicting perspectives of power, identity, access and language choice. Proceedings of the *ICMI Study 21 Conference: Mathematics Education and Language Diversity. Sao Paulo, Brazil*, 438-446.

Webb, P, & Webb, L. (2011). The introduction of exploratory talk to multilingual mathematics teachers through experiential learning. *Proceedings of the ICMI Study 21 Conference: Mathematics Education and Language Diversity*. Sao Paulo, Brazil, 447 -455.

Villanueva, MG. & Webb, P. (2011). The theoretical basis and the cognitive, linguistic and pedagogical advantages of code switching in multilingual classrooms of South Africa to address the three-language problem (home, school and science). *Annual International Conference of the National Association for Research in Science Teaching (NARST).* Orlando, United States of America. 114.

Webb, L. & Webb, P. (2011). Strategies to promote the introduction of dialogic teaching in multilingual mathematics classes. *Episteme 4: An international conference to review research on Science, Technology and Mathematics Education.* Homi Baba Centre for Science Education, Mumbai: India. 202-206.

Kurup, R. & Webb, P. (2011). Does the classroom practice of science teachers reflect their conceptions regarding the nature of science? *Episteme 4: international conference to review research on Science, Technology and Mathematics Education.* Homi Baba Centre for Science Education, Mumbai: India. 53-57.

Webb, P. & Villanueva, M.G. (2010). A science and literacy approach towards greater inclusivity. *Inquiry-Based Science Education (IBSE) for Girls/Primary Connections Workshop*. South African Academy of Science, Pretoria, South Africa. 21-23

Villanueva, M. & Webb, P. (2010). A South African perspective for improving learners' scientific literacy. *Socio-cultural and Human Values in Science and Technology Education, IOSTE 14 Symposium*, Bled, Slovenia. 1528-1529

[3]Olander, C., [4]Lassbo, G., & Webb, P. (2010). Developing strategies for promoting scientific literacy. *Socio-cultural and Human Values in Science and Technology Education, International Organisation for Science and Technology Education, IOSTE 15 Symposium*, Bled, Slovenia. 1439-1441.

Drs Clas Olander[3] and Goran Lassbo[4] are academics at Gothenburg University, Sweden

Conference presentations

Webb, P. (2013). Scientific literacy, beautiful arts, and the harmonious transfer of learning. *Fifth Advanced International Colloquium on Building the Scientific Mind*. Lembang, Indonesia.

[5]Airey, J., [6]Linder, A., Mayaba, N. & Webb, P. (2013). Physics students' representational competence: South African Physics lecturers' teaching and curriculum response strategies. *16th Annual SAARMSTE Conference*. Cape Town, South Africa.

Linder, A., Airey, J., Mayaba, N. & Webb, P. (2013). Problematizing Disciplinary Literacy in a Multilingual Society: The Case of University Physics in South Africa. *16th Annual SAARMSTE Conference*. Cape Town, South Africa.

Webb, P. (2012) Crossing borders: Scientific literacy, general literacy and thinking. *Literacy without borders*. University of Gothenburg, Sweden.

Webb, P. (2011). Promoting reasoning skills via subject focus literacy approaches. *Fourth Advanced International Colloquium on Building the Scientific Mind*. Stellenbosch, South Africa.

Webb, L. & Webb, P. (2010) Using dialogue in mathematics classes: Could it aid mathematical reasoning? *13th Annual SAARMSTE Conference*. Durban, South Africa.

Dr John Airey[5] and Ms Anne Linder[6] are academics at the University of Uppsala, Sweden

Chapters in books

Webb, P. (in prep). Science education in South Africa: Issues of language and scientific literacy. In F. Otulaja, & M. Ogunniyi (Eds.), *The World of Science Education: Handbook of Research in sub-Saharan Africa*

Webb, P. & Villanueva, M-G. (in press). Culturally relevant schooling in science for indigenous learners worldwide: Stressing the all in science literacy for all. In N. Lederman (Ed.), *Handbook of*

Research on Science Education, pp.

Webb, P. (in press). Indigenous knowledge and science education: What knowledge, who's knowledge and how do we bridge the gap? In M.T Gumbo & V. Msila (Eds.), *Contemporary Perspectives on Africanisation of the Curriculum: Theory and Practice, Pretoria,* pp. South Africa: Unisa University Press

Webb, P. (2010). Talking and writing in the science classroom. In U. Ramnarain & X. Kyriacou (Eds.), *Teaching Scientific Investigations in the South African Classroom*. South Africa: Macmillan.

Publications emanating from the umbrella engagement project

Journal articles

Du Plessis, & Webb, (2012). A teacher proposed heuristic for ICT professional teacher development and implementation in the South African context. *Turkish Online Journal of Educational Technology, 11*(4), 46-55.

Du Plessis, A., & Webb, P. (2012). Teachers' perceptions about their own and their schools' readiness for computer implementation: A South African case study. *Turkish Online Journal of Educational Technology, 11*(3), 312-325.

Du Plessis, A., & Webb, P. (2012). Digital immigrant teacher perceptions of an extended Cyberhunt strategy. *Australasian Journal of Educational Technology,* 28(2), 341-363.

Du Plessis, A., & Webb, P. (2011). An extended Cyberhunts strategy: Learner centred learning-by-design. *Australasian Journal of Educational Technology*, 27(7), 1190-1207.

Du Plessis, A. & Webb, P. (2011). An extended 'learning by design' framework based on learner perceptions. *African Journal of Research in Mathematics, Science and Technology Education,* 15(2), 16-29.

Conference proceedings

Du Plessis, A. & Webb, P. (2012). A heuristic for higher level student cognitive thinking and questioning through collaborative student designed wiki-based cyberhunts. *7th international Conference on Science, Mathematics and Technology Education. Transformations through Science, Mathematics and Technology Education: Towards an Innovative and Sustainable Society*. Muscat, Oman.

Du Plessis, A. & Webb, P. (2012). Proposed ICT implementation heuristic for schools in disadvantaged contexts: An African perspective from South Africa. *Science and Technology Education for Development, Citizenship and Social Justice.* IOSTE 15 Symposium, Hammamet, Tunisia, 20pp.

Du Plessis, A. & Webb, P. (2010). The CRAR3FS2 framework for developing teachers' ICT skills for Science Education through Cyberhunts. *Socio-cultural and Human Values in Science and Technology Education, IOSTE 14 Symposium*, Bled, Slovenia. 361-371.

Appendix B

Doctoral theses directly based on scientific literacy strategy (or aspects thereof)

Boschmans, S-A. (2013). Teaching Pharmacology: Issues of language and learning in a multilingual classroom setting

Leonard, S. (2012). Education for sustainable development: Developing scientific literacy in its fundamental and derived senses.

Sepeng, P. (2011). Grade nine second-language learners in township schools: Issues of language and mathematics when solving word problems

Villanueva-Hay, M. (2010). Integrated teaching strategies model for improved scientific literacy in second-language learners

Webb, L. (2010). Searching for common ground: Developing mathematical reasoning through dialogue

Doctoral thesis emanating from the umbrella project

Du Plessis, A. (2010). The introduction of cyberhunts as a teaching and learning strategy to guide teachers towards the integration of computer technology in schools

Master's dissertations

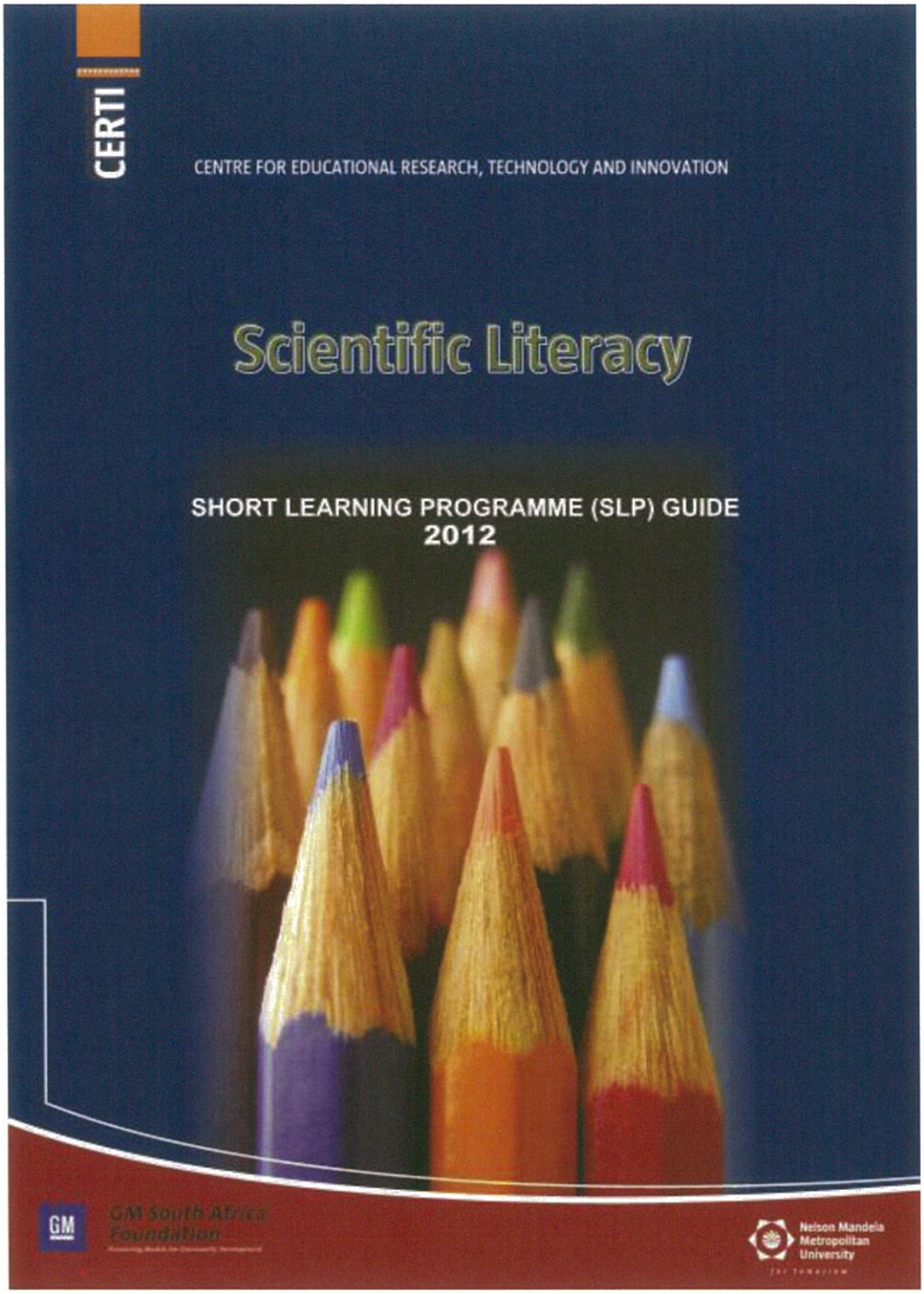
Loggenberg, E. (2013). Teaching and learning electrostatics using indigenous knowledge, everyday knowledge and scientific argumentation *(cum laude)*

Daniels, N. (2011). Promoting scientific literacy within a museum context *(cum laude)*

Mayaba, N. (2009). The effect of a scientific literacy strategy on grade 6 and 7 learners' general literacy skills *(cum laude)*

I was the sole promoter and supervisor of all the students listed above

Appendix C


CERTI
CENTRE FOR EDUCATIONAL RESEARCH, TECHNOLOGY AND INNOVATION
Scientific Literacy
SHORT LEARNING PROGRAMME (SLP) GUIDE
2012
GM South Africa Foundation
Nelson Mandela Metropolitan University

Integrated School Development and Improvement Project

Scientific Literacy

Short Learning Programme (SLP) Guide 2010

Paul Webb

Introduction

This 100 notional hours programme is offered to educators, departmental officials and persons involved in science education. It has been developed in response to the need expressed by researchers worldwide for improved achievement in science education and deeper understandings of scientific literacy. As such, the SLP attempts to empower individuals to respond to the challenges of developing authentic scientific literacy in schools.

Short Learning Programme layout

Unit 1: The notion of scientific literacy

Purpose of unit

In this unit we look at arguments for the kind of scientific literacy that empowers learners to be literate in the discourses of science, i.e. reading, writing and talking science. It also examines the notions of fundamental and derived senses of science and issues of language use in science teaching and learning. This unit also examines teaching practices using children's literature with a focus on shared reading and using stories in multilingual and multicultural classrooms

Statement of specific learning outcome(s)

On successful completion of this unit, you will be able to:

- Describe the requirements of scientific literacy
- Explain the 'three-language problem' and 'border crossing' in terms of science education
- Explain the differences between the fundamental and derived senses of science
- List and explain what is required to measure scientific literacy
- Explain the implications of scientific literacy for teacher development
- Use children's literature for teaching reading to learn science
- Move learners from reading to discussing

Unit 2: Classroom discussion and exploratory talk

Purpose of unit

In this unit we consider different authors' approaches to classroom discussion, briefly introduce the notion of alternative conceptions in science, look at a theoretical position for discussion and different types of classroom talk, and ways of promoting investigable questions in science classrooms.

Statement of specific learning outcome(s

On successful completion of this unit, you will be able to:

- Differentiate between different types of classroom discussion
- Expound the ground rules for exploratory talk
- Train a class in discussion skills
- Discuss arguments for home language and code switching in bilingual and multilingual classrooms
- Promote investigable questions in a science classroom

Unit 3: Planning an investigation

Purpose of unit
This unit aims to assist participants in deepening their understanding of the role of planning in scientific investigations. It considers issues of conceptual and procedural understanding, concepts of evidence, variables and validity and reliability. This unit will explore the measurement and data handling aspects of investigations and the presentation of data to differing audiences.

Statement of specific learning outcome(s)
On successful completion of this unit, you will be able to:

- Identify appropriate and inappropriate reasons for doing practical work in science
- Distinguish between conceptual and procedural understandings in science
- Articulate the notion of 'Concepts of Evidence' and how they are structured around the four main stages of investigative work
- Identify dependent, independent and control variables
- Present the data generated by an investigation in an effective manner

Unit 4: Doing an investigation

Purpose of unit
In this unit we look at discrepant events and cognitive dissonance when choosing an appropriate activity, turning activities into investigations, keeping cooperative groups on task, the nature of science, and the key differences between traditionally implemented hands-on activities and the inquiry-based type of investigations propagated in this module.

Statement of specific learning outcome(s)
On successful completion of this unit, you will be able to:

- Choose an appropriate activity for investigation
- Provide structure for the investigation and be able to facilitate cooperative work
- Get consensus from your learners on which variables should be controlled
- Differentiate between traditional hands-on practical activities and inquiry based investigations

Unit 5: Writing to learn science

Purpose of unit
In this unit you will be introduced to research on science and writing, the *'Science Notebook'* strategy, how to help learners use science notebooks for scientific investigations, and how to help learners extend their line of learning.

Statement of specific learning outcome(s)
On successful completion of this unit, you will be able to:

- Facilitate the successful use of the *science notebooks* approach
- Know the difference between science notebooks and journals
- Demonstrate effective strategies to extend the line of learning
- Assess learners science notebooks

Unit 6: Argumentation

Purpose of unit
In this unit you will be introduced to research on conceptual understanding, the process of argumentation, teachers' roles in promoting argumentation, argumentation writing frames, measuring argumentation, and presenting scientific arguments.

Statement of specific learning outcome(s)
On successful completion of this unit, you will be able to:

- Describe and explain the processes of conceptual change and the development of deep understandings
- Explain the differences between debating, questioning and argumentation
- Use the Toulmin writing frame for argumentation
- Distinguish between claims, data, warrants rebuttals and backings and effectively use them in argumentation

Unit 7: Assessing scientific literacy

Purpose of unit
In this unit we draw together all of the aspects of scientific literacy that we have covered and identify ways in which we can provide authentic formative and summative assessment.

Statement of specific learning outcome(s)
On successful completion of this unit, you will be able to:

- Assess learners scientific literacy in terms of the aspects covered in this module

Note: The above units may not be addressed sequentially during the SLP, but introduced when appropriate for effective teaching and learning.

Critical Cross-Field Outcomes

On completion of this module successful participants will be better equipped to be able to:

- Participate as citizens and contribute to discourses based on scientific literacy
- Solve problems which require scientific literacy;
- Work effectively as a member of a team through group work sessions and presentation of assignments;
- Display effective information management skills through the presentation of assignments;
- Demonstrate an understanding of the implications of societal decisions which are taken and which presume a higher level of scientific literacy;
- Show cultural sensitivity through the implementation of context appropriate teaching and learning strategies;
- Communicate effectively about issues regarding scientific literacy via coherent written assignments, and presentation of the findings of scientific investigations, etc.

Method of assessment

Formative and summative assessment will form an integral part of the SLP and includes the compilation of a portfolio and a final examination. You will be expected to complete all written assignments and keep a portfolio of your work, including examples of your own experiences. Where possible, the portfolio should include examples of your learners work. In order to pass the SLP you must attain passing grades for your portfolio and 2-hour examination.

The final assessment mark will be calculated as follows:

Continuous assessment (CA)	50%
Final examination	50%

Your portfolio will include a 1500-2000 word essay of your understanding of the theoretical aspect of the scientific literacy strategy used, and a journal of your experiences when using the strategy with learners and/or teachers. The examination will focus on your experiences and how they impacted on your understanding and future expectation of the scientific literacy strategy. An overall passing mark is 50%, but there is a sub-minimum mark of 40% for the CA section to be able to write the examination. To be able to write the examination participants must:

- ☐ Be officially registered for this SLP
- ☐ Have attended at least 75% of the contact time, and
- ☐ Have obtained the 40% sub-minimum for CA.

Required reading

England, V., Huber, R., Nesbit, C., Rogers, C. & Webb, P. (2007). *Scientific Literacy: A New Synthesis* (Ed: P. Webb). Bay Books: Port Elizabeth.

Fensham (2008). *Science Education Policy-making: Eleven Emerging Issues*. UNESCO. Section for Science, Technical and Vocational Education

Norris, S.P. & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education*, 87, 224-240.

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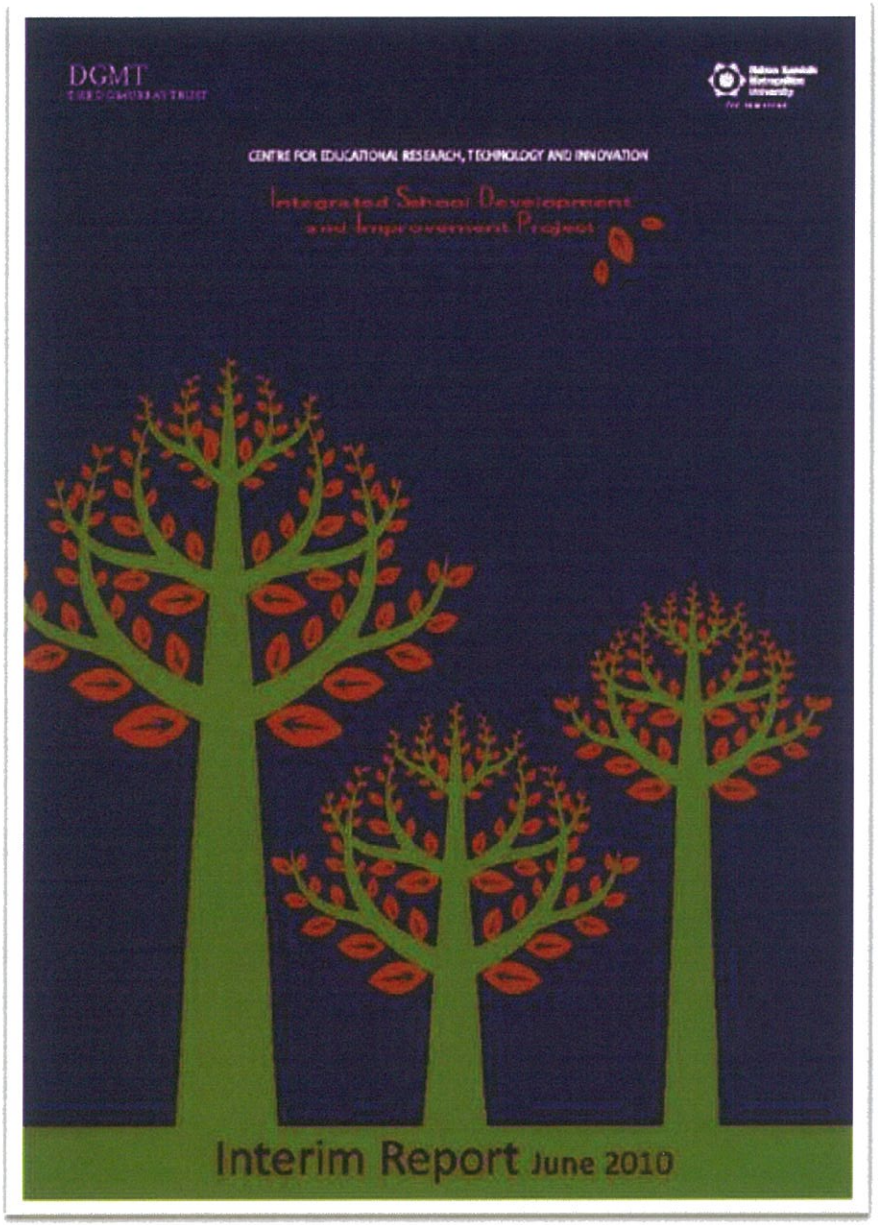
The scientific literacy book will be provided as a hard copy while the research papers will be provided in electronic form

Appendix D

Appendix E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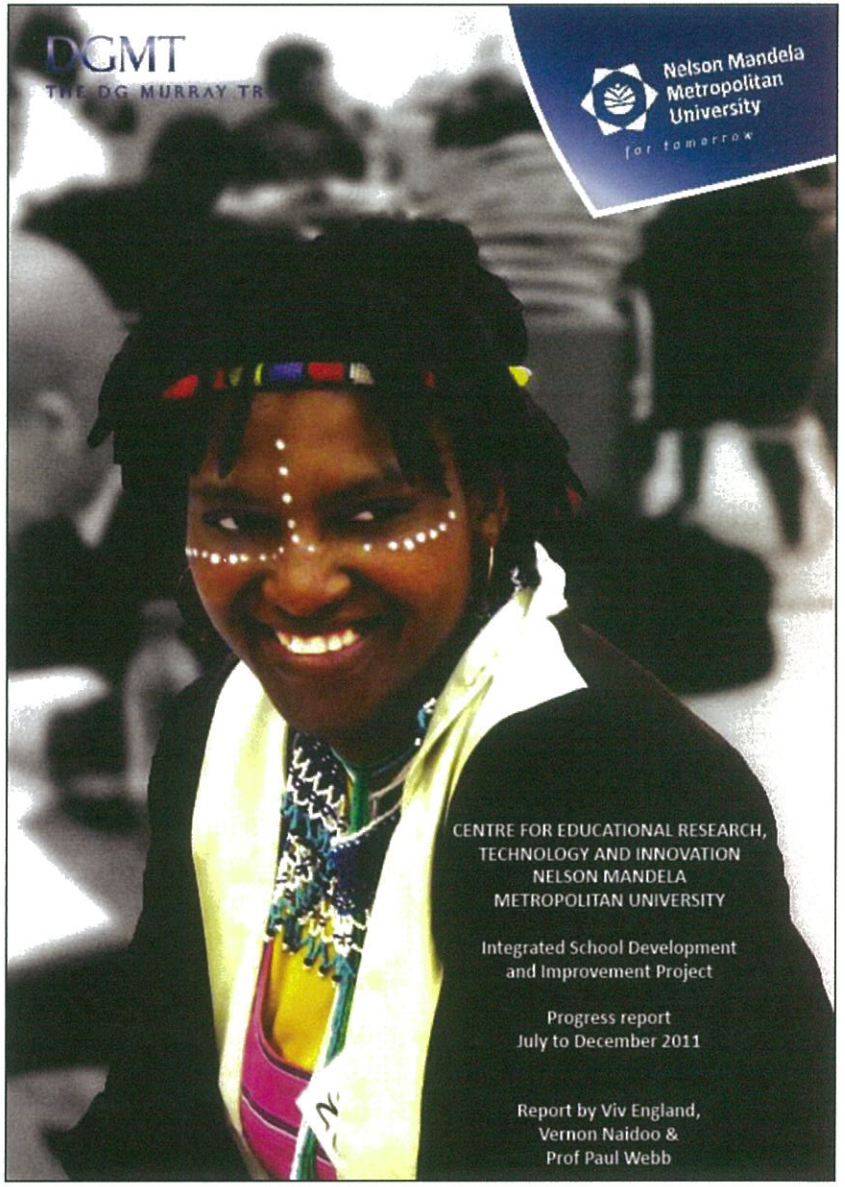
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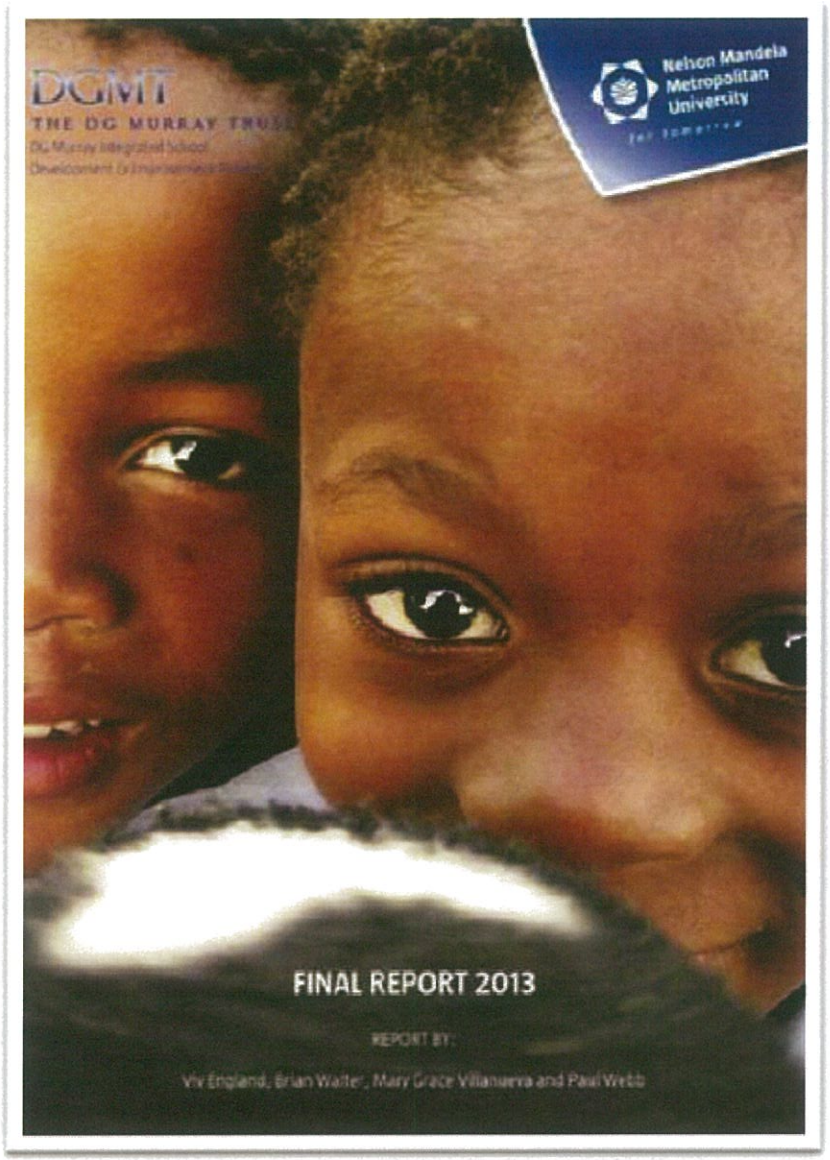
Integrated School Development and Improvement Project
Progress report July to December 2011
Report by Viv England, Vernon Naidoo & Prof Paul Webb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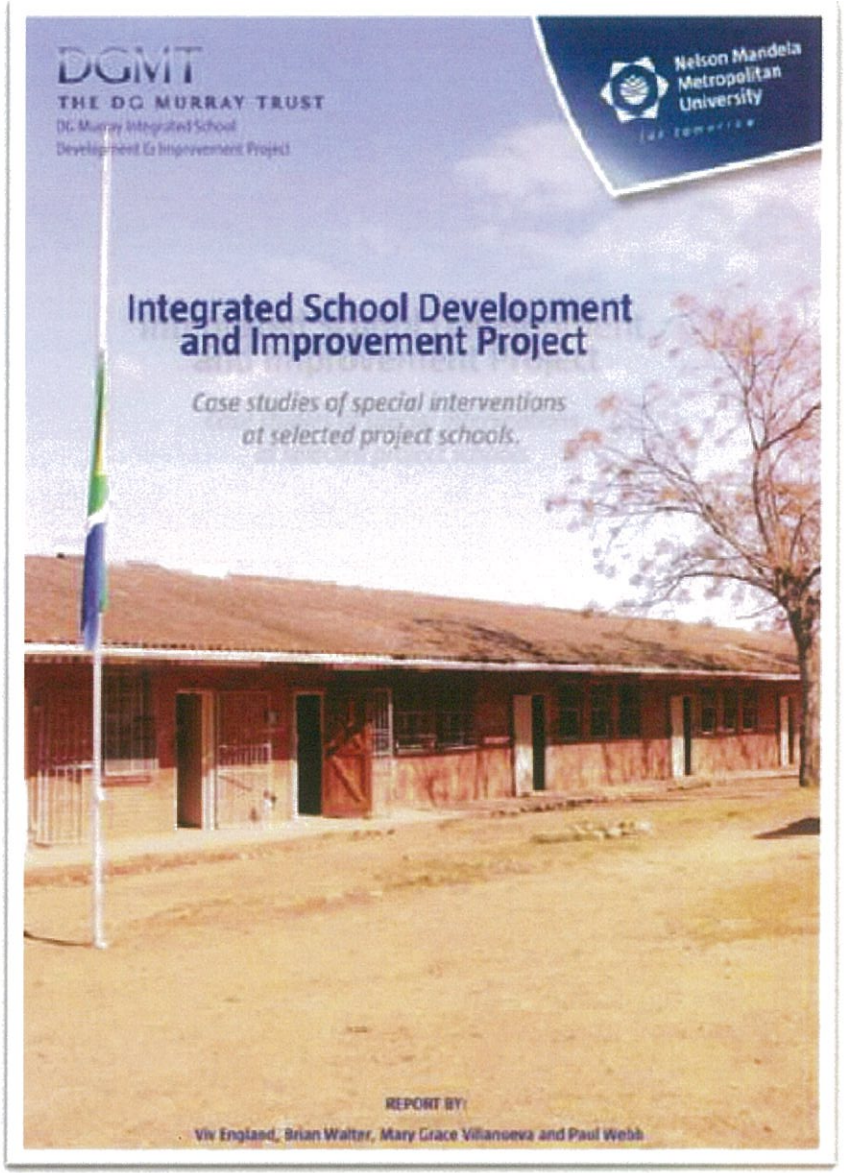
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REPORT BY:
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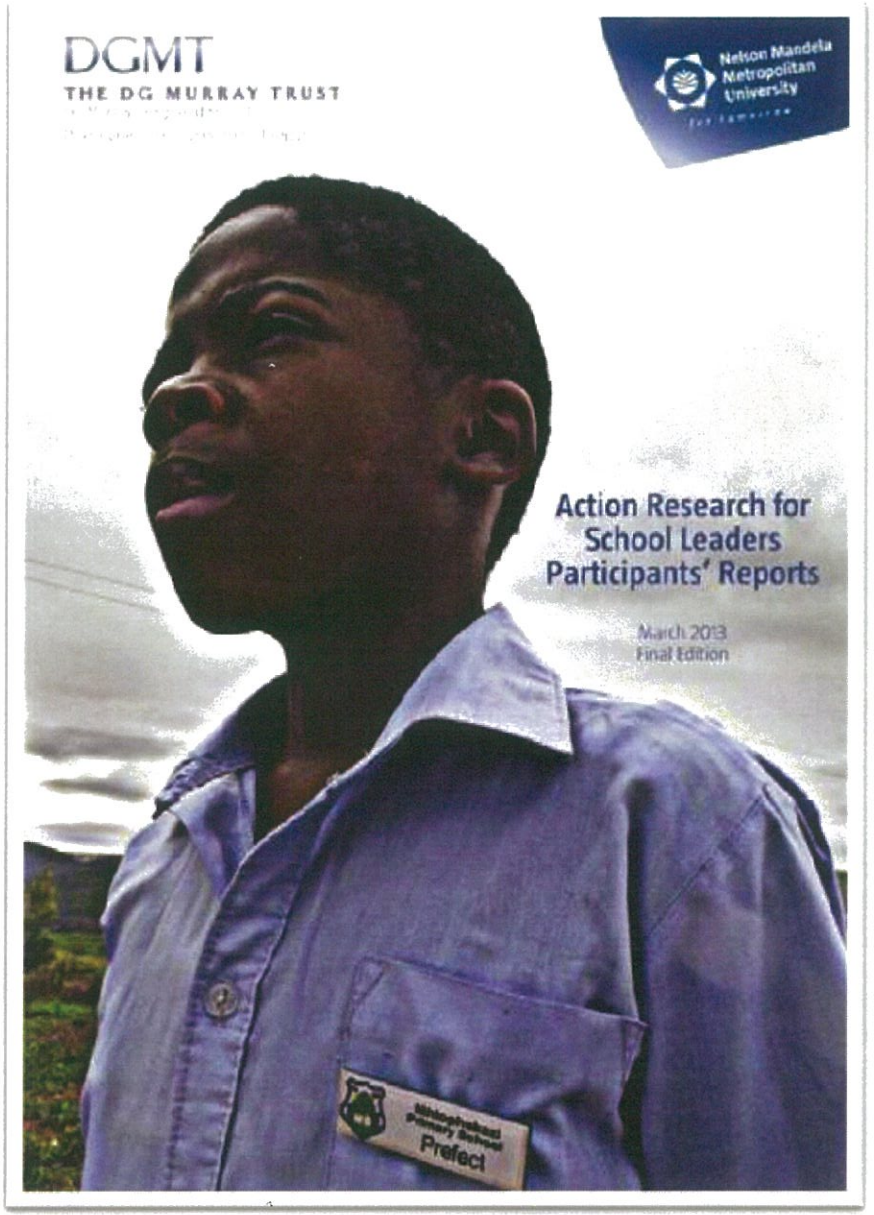
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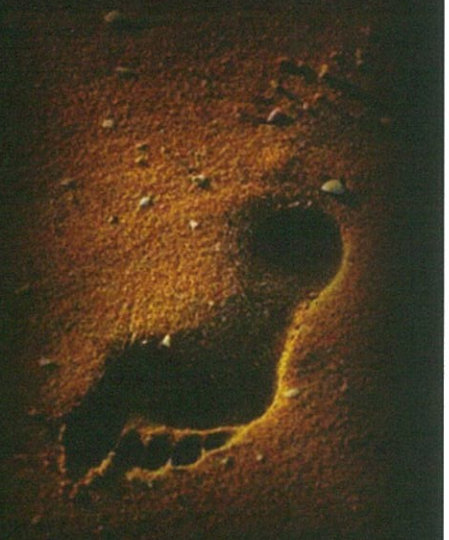
March 2013
Final Edition
Prefect

swedish - south african links project

An international collaborative research grant funded by the Swedish Vetenskapsrådet and South African National Research Council



Developing strategies for promoting scientific literacy: Cooperation focusing on empirical and theoretical challenges in South African and Swedish second language contexts

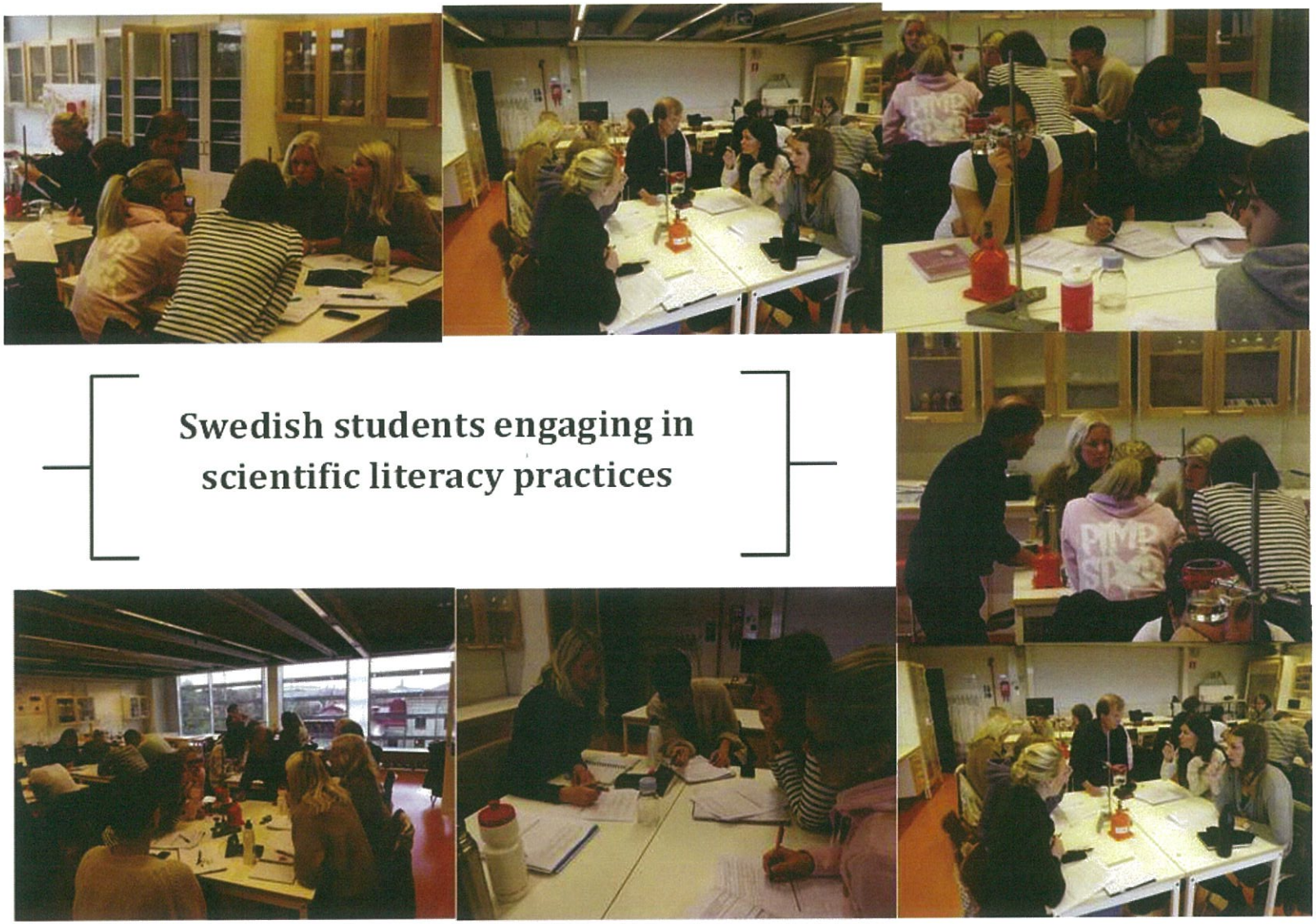
UNIVERSITY OF GOTHENBURG

Nelson Mandela Metropolitan University

Literacy without Borders

Stockholm University

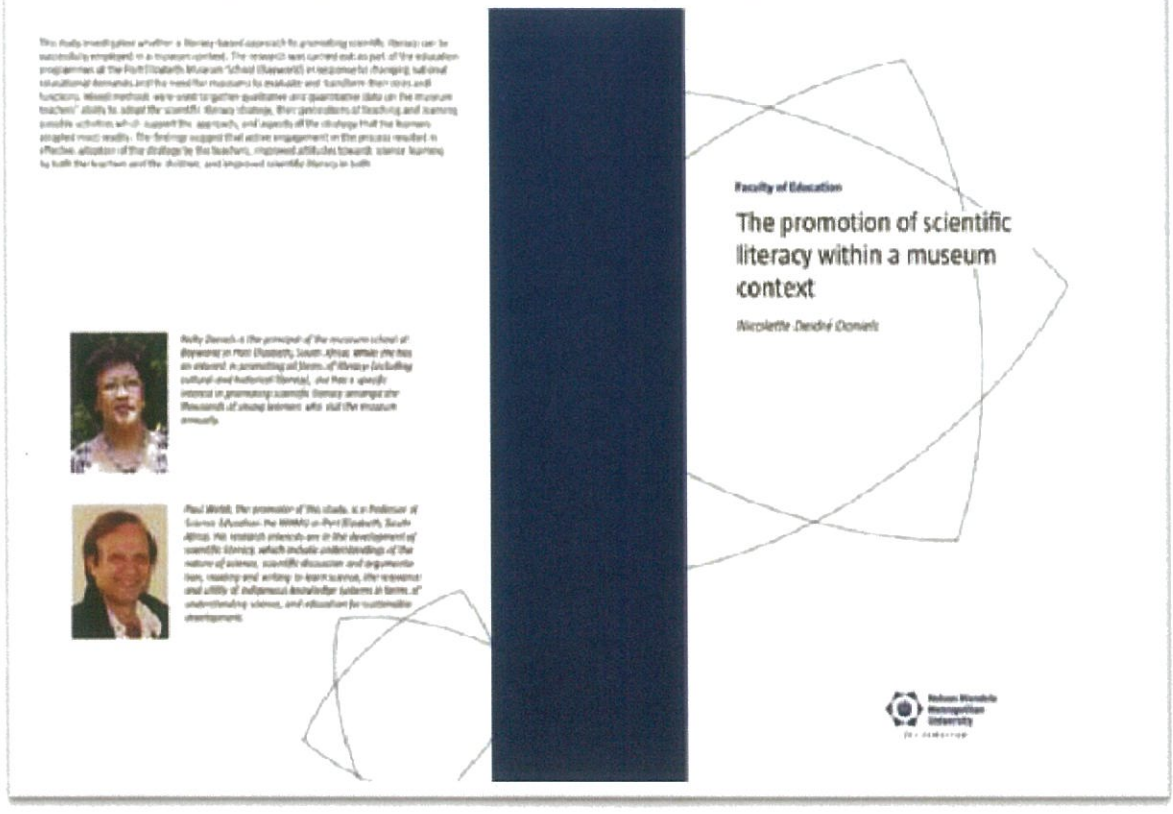
UNIVERSITY OF GOTHENBURG


Swedish students engaging in
scientific literacy practices

Faculty of Education

The effect of a scientific literacy strategy on grade 6 and 7 learners' general literacy skills

Nokhanya Nomakhwezi Mayaba



Faculty of Education

The promotion of scientific literacy within a museum context

Nicolette Dendré Comeis

In recent decades the focus of science education has moved from an emphasis on scientific skills and knowledge to developing scientific literacy in both its fundamental and derived senses. Education for Sustainable Development (ESD) aims at promoting scientifically literate societies where individuals are able to make informed decisions concerning the natural environment and the promotion of sustainable livelihoods. This study investigated the potential of a strategy which aims at promoting scientific literacy to contribute to the teaching and learning of ESD topics by developing more scientifically literate learners in primary education.

The study sample included nine teachers and 243 learners in seven schools. Qualitative and quantitative data were generated through teacher interviews, analysis of teaching portfolios, classroom observations, learner tests and their science notebooks. The quantitative data provided descriptive statistics and inferential statistics were generated via analysis of variance (ANOVA) techniques. The quantitative and qualitative data were triangulated and the findings were that successful use of the strategy by the teachers improved learners' scientific knowledge and skills significantly and provided authentic opportunities for teachers to integrate issues relating to sustainable development into their natural science lessons. Use of the strategy also enabled the learners to engage in autonomous learning environments, aspects of which have been identified as being important for meaningfully learning about, and internalising, important issues related to ESD.

Samantha Leonard is a lecturer in the Department of Development Studies at NMMU. Her research interests include people-centered development, sustainable livelihoods and education and development. Sam is passionate about inspiring students to think differently, to question what they have always accepted, and hopefully, to decide to live in such a way that they might make a difference to the world around them.

Paul Webb, the promoter of this study, is Professor of Science Education at the NMMU. His current interests are in language and literacy as they apply to the teaching and learning of Science and Mathematics.

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Scientific Literacy and Education for Sustainable Development: Developing Scientific Literacy in its Fundamental and Derived Senses

Samantha Lee Leonard

Nelson Mandela Metropolitan University

Grade 9 second-language learners in township schools: Issues of language and mathematics when solving word problems

Second language (English) learning of mathematics is common in South African mathematics classrooms, including those in the Eastern Cape Province of South Africa where isiXhosa speakers are taught in a language that is not spoken at home by either teachers or their students. The purpose of this research was to investigate issues of both home language (isiXhosa) and the language of learning and teaching, i.e. English, when 9th grade second-language learners engage in problem-solving and sense-making of real world problems in multilingual mathematics classrooms. In addition, the study also explored whether the introduction of discussion and argumentation techniques in these classrooms can ameliorate these issues. The study used a pre-test–intervention–post-test mixed method design utilising both quantitative and qualitative data. The data collection strategies included interviews, classroom observations, and testing in four experimental and two comparison schools in township around Port Elizabeth.

Analysis of the data generated from pre and post-tests, interviews and classroom observation schedule suggest that the intervention strategy significantly improved the experimental learners' problem-solving skills and sense-making abilities in both English and isiXhosa (but more significantly in English), and that the introduction of discussion and argumentation techniques in the teaching and learning of mathematics word problems had a positive effect on learners' ability to consider clearly during word problem-solving. There was also evidence of the benefits of code-switching throughout most of the lessons observed, coupled with instances of peer translation, and/or self-voicing. Overall results in this study illustrate that number skills employed and mathematics errors made by learners seem to be directly related to language use in the classroom.

Percy Sepeng is a Lecturer in Mathematics and Mathematical Literacy Education at the University of the Witwatersrand. His interest lies in the enhancement of mathematical modelling and/or problem-solving through promoting argumentation and introducing discussion as the strategies in the teaching and learning of mathematics in multilingual classroom settings.

Paul Webb, the promoter of this study, is Professor of Science Education at the NMMU. His current interests are in language and literacy as they apply to the teaching and learning of Science and Mathematics.

Faculty of Education

Grade 9 second-language learners in township schools: Issues of language and mathematics when solving word problems

Percy Sepeng

Nelson Mandela Metropolitan University

Integrated teaching strategies model for improved scientific literacy in second-language learners.

In light of South Africa's learner performance on national and international assessments such as TIMMS (2003) and PIRLS (2006), as well as the clearly identified problems of teaching and learning in a second language, there appears to be a pressing need to develop learners' fundamental sense of scientific literacy. Expanding learners' ability to read, write and communicate in science may provide the necessary framework for engaging learners in the critical principles and foundations of the scientific endeavour. As such, this study focuses on equipping and training grade six and seven science teachers to develop scientifically literate learners via professional development workshops that support reading, writing, talking and conducting scientific investigations.

The study was conducted in two different milieus in the Eastern Cape, South Africa. The first setting, in the rural area of Tyumie Valley near the Mogalbeck Mountains, comprised of a sample of grade six and seven (multi-grade classrooms) teachers (n=7) and learners (n=168) from five experimental schools and two comparison schools. The second setting, in the urban townships area east of Port Elizabeth, comprised of a sample of grade six teachers (n=8) and learners (n=675) from six experimental schools and two comparison schools. The data generated suggest that the scientific literacy strategy used improved the experimental learners' problem solving and literacy skills in isiXhosa and English. While some teachers cited difficulties with certain aspects of the model, such as problems with developing an investigable question and argumentation, gradual improvements suggest that the scientific literacy strategy used was appropriate in terms of supporting cognitive and linguistic development in second-language learners of science.

Mary Grace Villanueva is a lecturer in Science Education. Her interest lies in promoting Scientific Literacy particularly in terms of writing to learn strategies.

Paul Webb, the promoter of this study, is Professor of Science Education at the NMMU. His current interests are in language and literacy as they apply to the teaching and learning of Science and Mathematics.

Faculty of Education

Integrated teaching strategies model for improved scientific literacy in second-language learners

Mary Grace Villanueva

Nelson Mandela Metropolitan University

'Searching for common ground: Developing mathematical reasoning through dialogue'

In the majority of the schools in the Eastern Cape, South Africa, teaching and learning takes place in the second language, English, of both teachers and learners. The purpose of this research was to elicit the perceptions of teachers in multilingual mathematics classes about language issues that they encounter and to ascertain whether they could experientially learn the theory of dialogic teaching through an intervention aimed at introducing dialogue in these classes. The effect of the intervention was qualitatively observed and the effect of the teacher practices on learner reasoning competence, numeracy competence and English language competence was quantitatively tested using established pre- and post-tests.

The results of this study highlight the validity of the Vygotskian claim concerning the relationship between language use, social interaction and reasoning development. In classes where there was evidence of dialogic practices including code-switching, the learners' reasoning, numeracy and English skills test scores improved statistically significantly. When teachers focused on developing language as a tool for reasoning, significant improvements in learners' problem solving competences occurred. When the language used is the main language of both teachers and learners, both mathematical understanding and cultural identity are enhanced. The study concludes with a suggested model for future interventions to train teachers to introduce dialogic practices in multilingual mathematics classes.

Lyn Webb is a lecturer in Mathematics and Mathematical Literacy Education at NMMU. Her interest lies in the enhancement of mathematical reasoning through the development of exploratory talk in multilingual mathematics classes in all phases of education.

Paul Webb, the promoter of this study, is Professor of Science Education at the NMMU. His current interests are in language and literacy as they apply to the teaching and learning of Science and Mathematics.

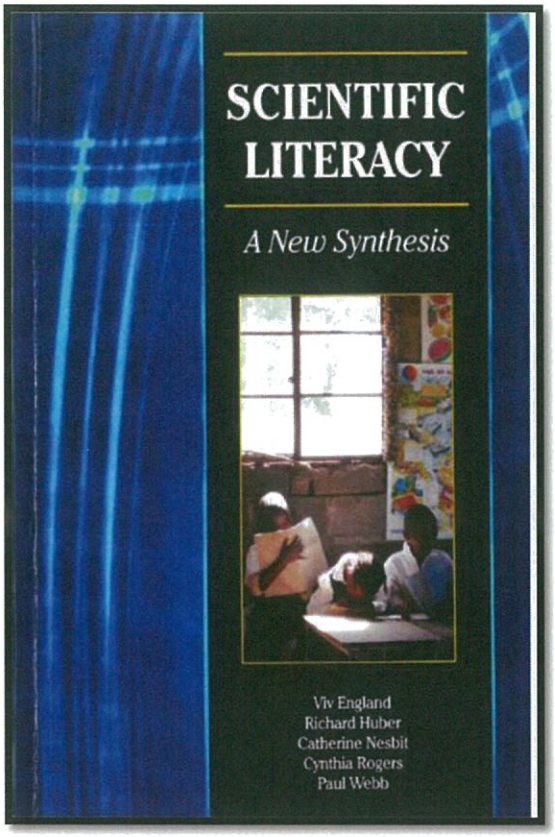
Lyn Webb and Paul Webb are not related by blood or marriage.

Faculty of Education

Searching for common ground: developing mathematical reasoning through dialogue

Lynette Webb

Nelson Mandela Metropolitan University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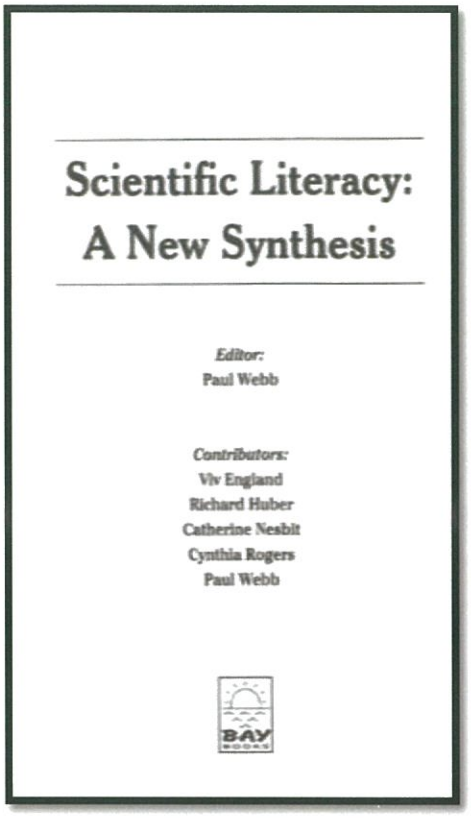
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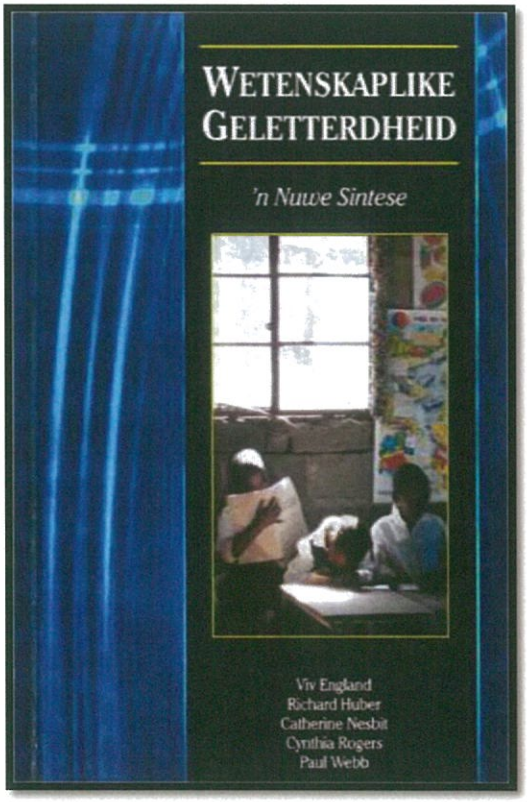
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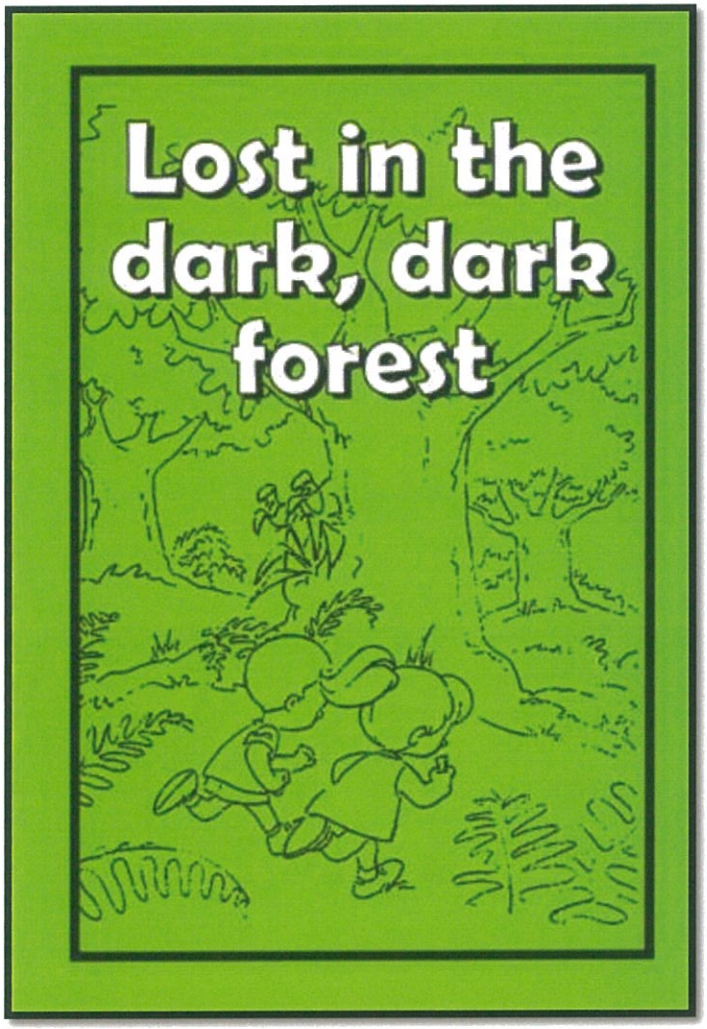
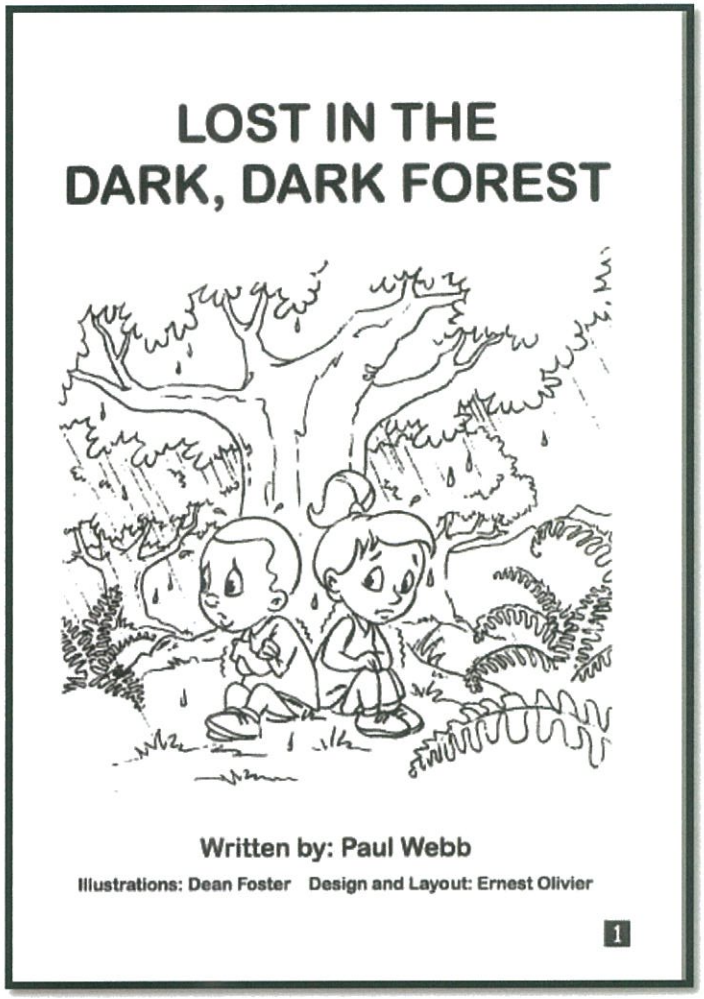

Lost in the dark, dark forest


LOST IN THE DARK, DARK FOREST
Written by: Paul Webb
Illustrations: Dean Foster Design and Layout: Ernest Olivier
1