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Siemens/Stiftung Experimento 10+ University of the Western Cape – School of Science and mathematics Education (SSME) Collaborative Science Project Report 2013

Evaluation Report for Period June 2013 to November 2013

This summary report provides a reflection on the projects progress over a six month period, commencing in June 2013, of which prior reports were submitted. We reflect on the teacher network and their qualitative evaluation of the use of the science kits. Our brief as the School of Science and Mathematics (SSME) was to set up a pilot investigation into the efficacy of trained science teachers in the use of Experimento10+ and forward any recommendations proffered by participants on successes and challenges faced by science teachers when using the kits. Teachers' impressions and critiques were positive and are reflected. Recommendations and the way forward is proposed by UWC-SSME facilitators as we enter the second and final evaluation period from January 2014 to June 2014.

Keith Roy Langenhoven & Shafiek Dinie

11/26/2013

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1. Project Brief

The objectives of the initial project, to be implemented in 2013, were as follows:

a) To equip a selected number of teachers in the Western Cape Province, South Africa, with knowledge and skills to implement the National Curriculum Statements (NCS-Sciences) supported by the Curriculum and Assessment Policy Statements (CAPS) for sciences through practical experiment kits supplied by Siemens Stiftung.
b) To workshop exemplary support materials provided by Siemens Stiftung Experimento10+, Germany, for the teaching of science, incorporating an inquiry-based experimental platform.
c) To identify both urban and rural under-resourced primary and secondary schools throughout the Western Cape Province, who could derive benefit from such materials.
d) To introduce an integrated freely accessible online web-based inquiry science platform for science teachers.
e) To develop a reflexive action-research based community of practice in an area where research capacity is very low amongst science teachers and within an authentic African context.
f) To support the integration of Indigenous Knowledge (IK) into the teaching and learning of science, wherever possible in the General Education and Training Phase (GET- Grades 7 to 9) and Further Education and Training Phase (FET – Grades 10 to12).
g) To initiate and conduct multi-disciplinary research as an integral component of the institutional intervention initiative in science education at school level so that the Education Department and the Department of Science and Technology will have the much needed information on what, why and how much is required to implement the THREE Specific Aims: Knowledge, Skills and Values as suggested by education policy in the formal schooling system.

In **summary** therefore, the objectives of this project can be described as:

- Building an inquiry-based science capacity for Science (including health and environmental science) and Technology teachers;
- Develop a community of skilled pre-and in-service science teachers;
- Provide efficacy, confidence and competence in the implementation of science materials for conceptual understanding;
- Generate an Information Database for support and collaboration between the German School, School of Science and Mathematics Education (UWC) as hubs of excellence and pre-and in-service teachers at under-resourced schools

The **project objectives** articulates directly with and supports the goals of the vision CAPS in the South African context. The objectives also accord with the vision of the Department of Science and Technology, inter alia, to build up a pool of demographically representative and community-based human capital amongst the youth as a pre-requisite for socio-economic growth and an improved quality of life.

The **primary target** for this project was a cohort of teachers who worked in science education in their school communities by cascading their acquired knowledge and skill to their colleagues and learners in their care. The project supported selected science teachers in the GET and FET phases at selected under-resourced schools with workshops on the use of Experimento 10+ kits. Pre-and in-service teachers are supported through professional pedagogical development activities and workshops run by indentured science methodology lecturers located at the School of Science and Mathematics Education, with guest visits by designers of Experimento 10+.

2. Background to the report

This summary report provides a reflection on the projects progress over a six month period, commencing in June 2013, of which prior reports were submitted. We reflect on the teacher network and their qualitative evaluation of the use of the science kits. Our brief as the School of Science and Mathematics (SSME) was to set up a pilot investigation into the efficacy of trained science teachers in the use of Experimento10+ and forward any recommendations proffered by participants on successes and challenges faced by science teachers when using the kits. Teachers' impressions and critiques were positive and are reflected. Recommendations and the way forward is proposed by UWC-SSME facilitators as we enter the second and final evaluation period from January 2014 to June 2014.

Having gone into negotiations to collaborate on this project in 2012, the MOU was eventually completed to the satisfaction of all parties in this agreement, namely University of the Western Cape and Siemens Stiftung by early 2013. To initiate the implementation process required funding and provisioning of the Experimento10+ kits. These requirements were complied with by the first semester of 2013 and proceeded with on-site visits to the urban cohort (UWC Undergraduate and Postgraduate pre-service teachers) and the rural cohort (Oudtshoorn and Beaufort West in-service teachers) by **Rebecca Ottmann, Dieter Arnold (Siemens Stiftung representatives), Keith Roy Langenhoven and Shafiek Dinie (UWC-SSME representatives).** The stage was set to implement the roll-out plan of workshops, school observation visits and alignment of experiments with the South African Curriculum and Assessment Policy Statement (CAPS) for sciences. The logistics of delivery centered around student teachers and teachers' availability on account of their study programme and teaching time respectively. The report therefore provides a concise analytical lens with which to measure a sustainable way forward to completion. Enjoy the read!

3. Participants on the Project

The following table provides a summary of the groups target according to the MOU between UWC and Siemens/Stiftung that came into effect in June 2013.

Group	Sample	Training Region
1	16 x In-service science teachers (Urban)	Deutsch Schule, Kapstadt
2A	16 x Pre-service BED 3rd year science education students (Teachers in Training GET phase Grade: 7 to 9)	School of Science and Mathematics, University of the Western Cape
2B	25 x Pre-service Post Graduate Certificate of Education (PGCE) science education students (Teachers in Training FET phase Grade: 10 to 12)	School of Science and Mathematics, University of the Western Cape
3	14 x In-service science teachers (Rural)	Oudtshoorn & Beaufort West, Western Cape Province

The Participants

Group 1: Sixteen (16) x Urban In-service science teachers. Training conducted by facilitators of Deutsche Schule Kapstadt (DSK)

Participants	School	Participants	School
Philander P.	Esselen Park Primary	Bezuidenhout S.	De Kruine Secondary
Cupido S.	Esselen Park Primary	Oosthuizen F.	De Kruine Secondary
Roberts S.	Vooruitsig Primary	Brown J.	Esselen Park Secondary
Thomas J.	Vooruitsig Primary	Speelman M.	Esselen park Secondary
Peters M.	Voorbrug Primary	Matosi T.	CoSat
Bezuidenhout S.	Voorbrug Primary	Sizani D.	CoSat
Cunningham B.	Kuilsrivier Technical High	Lawrence M.	St. Andrews High
Voges J.	Kuilsrivier Technical High	Mentz V	Rosendal High

Group 2A: Sixteen (16) x Pre- Service teachers at University of the Western Cape at the School of Science and Mathematics Education (BED 3rd year Group – Four year programme)

Participants	School	Participants	School
Amra T.	UWC - SSME	Lamprecht C.	UWC - SSME
Arendse R.C	UWC - SSME	Petersen T.	UWC - SSME
Dyasopu L.	UWC - SSME	Rawoot S.	UWC - SSME
Gamiet F.	UWC - SSME	Roos LA.	UWC - SSME
Gasnolar R.	UWC - SSME	Scheepers C.	UWC - SSME
Jackson P.	UWC - SSME	Schoeman L.	UWC - SSME
Julie M.	UWC - SSME	September T	UWC - SSME
Klaase L.	UWC - SSME	Thomas D.	UWC - SSME

Group 2 B: Twenty – Five (25) x Pre- service teachers at University of the Western Cape at the School of Science and Mathematics Education (Post Graduate Certificate of Education (One year programme)

Participants	**School**	**Participants**	**School**
Allie, F	UWC - SSME	Erasmus, L	UWC - SSME
Anshoma, M	UWC - SSME	Fernandez, A	UWC - SSME
Ayford, E	UWC - SSME	Floris, A	UWC - SSME
Benjamin, B	UWC - SSME	Fortune, C	UWC - SSME
Brown, D	UWC - SSME	McCann, L	UWC - SSME
Chotia, E	UWC - SSME	Mkoko, F	UWC - SSME
Cook, J	UWC - SSME	Mvalwana, O	UWC - SSME
Noah, K	UWC - SSME	Nomdumo, B	UWC - SSME
Ntobela, L	UWC - SSME	Oliver, N (twin)	UWC - SSME
Oliver, N (twin)	UWC - SSME	Parks, B	UWC - SSME
Rafik, M	UWC - SSME	Rass, W	UWC - SSME
Salomo, J	UWC - SSME	Williams, C	UWC - SSME
Zuzani, L	UWC - SSME		

Group 3: Sixteen (16) x Rural science teachers in the Oudtshoorn and Beaufort West areas of the Western Cape Province.

Oudtshoorn and Beaufort West District		
SCHOOL	**TEACHERS**	
Bergsig Primary School	Muller K. Arends D.	
Colridge Primary School	Muller F.	
De Villiers Primary School	Rensburg R.	
Saturnus Primary School	Jacobs E. Van Rooyen B	

Protea Primary School	Mei S	
Sacred heart Primary School	Maart J.	
Morester Senior Secondary	Pharo M.	
Aurial College	Strydom E.	
Bridgton Senior Secondary	Witbooi J Stalmeester C.	

A.H.Barnard Primary & A. H. Barnard Senior Secondary ***Beaufort West***	Meintjies, G (blue) Steenkamp, S	
St. Matthews ***Beaufort West***	Grant, E (purple) Buis, A	
View of previous type of house school in the area, now derelict		
Karoo, Semi-arid landscape in which many schools are situated		
Matjiesfontein, Lord Milner, in middle of Karoo. Colonial era		

Teacher participants and teacher distribution over primary and high schools on the Project

Figure1 below summarizes the number of teacher types that were part of the project.

Teacher Type	Actual number	%
No of Practicing Teachers	32	44%
No of 3rd Year UG Pre-Service Teachers	16	22%
No of Final year PGCE Pre-Service Teachers	25	34%

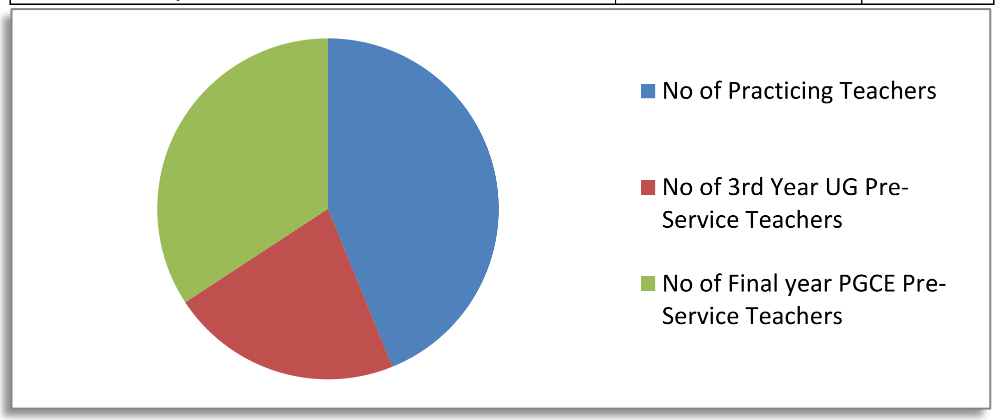

Figure1: Pie Graph of number of Teacher Types on Project

Figure 2 below illustrates the number of the type of school involved on the project.

Type of School	Actual Number	%
Primary Schools	13	55%
High Schools	9	45%

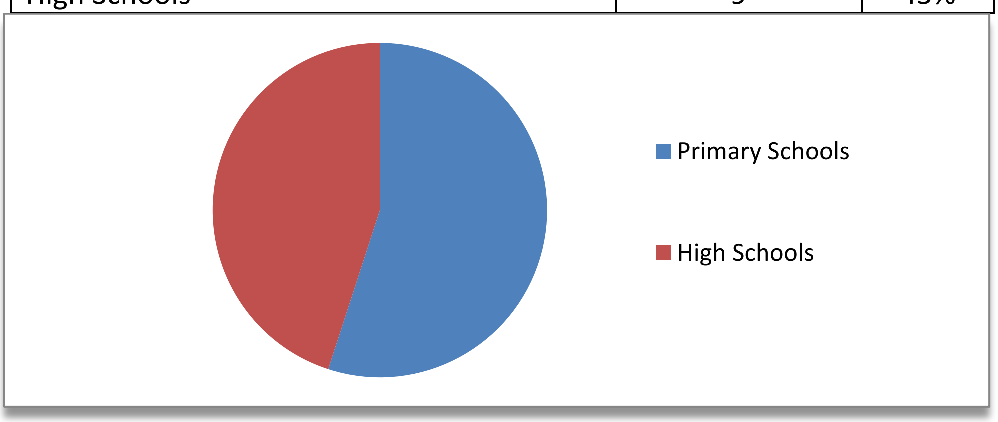

Figure 2: Pie Graph of Type of School on Project

Note: A total number of 73 participants participated and were exposed to the Experimento 10+ training programme.

4. Evaluation Methodology

The following summary is intended to highlight the evaluation of the Experimento 10+ Kits by the 75 participants.

Group1 Training: At Deutsche Schule Kapstadt

This group was facilitated by the school's science facilitators on the program. It entailed sessions after schools with experiments demonstrated and teachers having the opportunity to apply themselves. The debriefing session was held to ascertain usage, successes and challenges faced when using the Experimento10+ kits in daily lessons.

Group 2 Training: UWC Undergraduate and Final year pre-Service teachers

In addition to the science curriculum in the respective study years, training sessions entailed working through the sets of Experimento 10 + experiments, demonstrating some and having the students demonstrate their own competence in performing implementation of the experiments through presentations to their peers. In this way we were able to ascertain the ease or otherwise with which student teachers handled the experiments and understood the consolidation of the scientific concept required as per the science curriculum policy statements. These sessions were further extended with debriefing sessions regarding their experience of the experiments.

Group 3 Training: Rural group – Oudtshoorn and Beaufort West

The facilitators conducted four, 3 (three) day contact sessions over the period June 2013 to November 2013 with this group after school and the last session usually ended on a Saturday, where the main focus was on consolidation and debriefing, focusing on their experiences, highlighting their experiences and consolidating any challenges and/or successes.

After each session, they were given an opportunity to conduct the experiments by themselves and in their peer groups prepare for follow-up sessions. Initial visits to classrooms were conducted in order to observe how the materials were being used and to observe learner reception and interactions within this learner- centered approach to teaching and learning science concepts aligned to CAPS.

5. Evaluation Overview

Analysis Summary

The following discussion is based on the analysis of the data that was collected from all 3 groups over the Period June 2013 to November 2013. The analysis of the data, collected through our interaction with the participants, our own observations of their practices on the project and through discussions and debriefing sessions over the past three months, revealed in summary the following main focus discussion points as elaborated below.

(i) Alignment and Relevance of Experimento10+ to the South African Curriculum and Assessment Policy Statements (CAPS) Sciences Grade 8 – 12.

The tables below are intended to show how the materials and experiments in the Experimento 10+ kits align with the current Science Curriculum and Assessment Policy Statement (CAPS) for grades eight to twelve. Full tables are found in Addendum A which outlines in more detail the contents of the kits and how the actual experiments can be facilitated in support of CAPS.

Grade 8	Experiment In Experimento10 +	Grade 9	Experiment In Experimento10 +
Electricity			
Electrical energy/ Charges/Circuits/ Static electricity Cells/batteries as chemical systems - Resistors in series and in parallel - Effects of a current: - Electrolysis of Copper II Chloride - Light energy and the visible spectrum - output device: beeper, buzzer, LED, motor - input device: photocell	**A5** Properties of Solar cells Voltage, Power and current **B6**. Renewal energies – Sun, water, wind, hydrogen and fuel cells.	Forces (e.g. Magnetism)	**B3** How does waster separation work? Separating materials by density and magnetism.
Three states of matter	**A2** We store heat. From heat store to molten salt	Cells as chemical systems and sources of energy	**A3** Lemon batteries and other batteries. Electricity form chemical energy.
Compounds and elements Difference between mixtures and pure substances	**B6**. Renewable energies – sun, water, wind hydrogen and fuel cell	Cells connected in series and parallel/voltages and current	**A3** Lemon batteries and other batteries. Electricity form chemical energy.
Elements react to form compounds: Chemical reaction results in a different substance (compound) being formed Reactants: substances that react with one another Products: substances that are produced in the reaction.	**A1** Electric current from solar cells – a dye sensitized solar cells. (to supplement)		

Grade 10	Experiment In Experimento10 +	Grade 10	Experiment In Experimento10 +
Term 1		**Term 2**	
Do experiment with paper chromatography to show that water soluble ink-pens or —Smarties are not pure colours, but are mixtures of colours	**B4** We produce drinking water. Methods of purifying water.	Use apparatus for hydrogen combustion to burn hydrogen in oxygen. Is this a physical change or a chemical change? (Explain)	**B6** Renewable energies – Sun, water, wind, hydrogen and fuel cell.
Test copper, lead, aluminium, zinc, iron, sulphur, carbon, iodine, graphite and silicon to determine whether they have metallic, metalloid or non-metallic character. How are these elements used in industry?	**A5** Properties of solar cells- Voltage , current and power.	Pattern and direction of the magnetic field around a bar magnet.	**B3** How does waster separation work? Separating materials by density and magnetism.
Test the following substance to classify them as heat conductors, or insulators: glass, wood, graphite, copper, zinc, aluminium and materials of your own choice.	To complement	Set up a circuit to measure the *EMF* and potential difference and get learners to try to account for the discrepancy.	**A5** Properties of solar cells- Voltage , current and power.
Test the following substance to classify them as magnetic, or nonmagnetic: glass, wood, graphite, copper, zinc, aluminium, iron nail and materials of your own choice.	**B3**. How does waster separation work? Separating materials by density and magnetism.	Practical Demonstrations: Set up a circuit to measure the current flowing through a resistor or light bulb and also to measure the potential difference across a light bulb or resistor.	**A5** Properties of solar cells- Voltage , current and power.
Start with ice in a glass beaker and use a thermometer to read the temperature every 10 seconds when you	**A2** We store heat. From heat store to molten salt	Prescribed experiment: (Part 1 and part 2) Part 1 Set up a circuit to show	**A5** Properties of solar cells- Voltage , current and power.

determine the heating curve of water. Do the same with the cooling curve of water starting at the boiling point. Give your results on a graph.		that series circuits are voltage dividers, while current remains constant.	

Grade 10 (Continued)	**Experiment In Experimento10 +**		
Term 1		Term 2	
Recommended Formal Assessment Experiment (Chemistry): Heating and cooling curve of water.	**A2** We store heat. From heat store to molten salt	Prescribed experiment: Part 2 Set up a circuit to show that parallel circuits are current dividers, while potential difference remains constant.	**A5** Properties of solar cells-Voltage , current and power.
The electrolysis of water (sodium sulphate added) to give products. Identify the elements and the compounds	**A2** We store heat. From heat store to molten salt	Practical Demonstration: Conversion of Energy (qualitative)	**A3** Lemon batteries and other batteries. Electricity form chemical energy. **A5** Properties of solar cells-Voltage , current and power **B6** Renewable energies – Sun, water, wind, hydrogen and fuel cell. **B7** Capacitor, hydrogen, redox flow – we store renewable energy.

Grade 11	Experiment In Experimento10 +
Term 3	
Recommended project for formal assessment: Investigate endothermic and exothermic reactions (Identify and explain the applications of exothermic and endothermic reactions in everyday life and industry)	**A3** Lemon batteries and other batteries. Electricity from chemical energy.

Grade 12	Experiment In Experimento10 +
Term 2	
Effect of catalyst – hydrogen peroxide and manganese dioxide; burning a sugar cube with and without dipping in activated carbon. Also adding a piece of copper to the reaction between zinc and HCl will accelerate the rate.	**C1** We burn sugar. Cellular respiration and breathing chain. **C2** Carbohydrates as providers of energy for metabolism – Starch & sugar.
Determine the internal resistance of a battery.	**A5** Properties of solar cells- Voltage , current and power
Term 3	
Electrolytic cells and galvanic cells	**A3** Lemon batteries and other batteries. Electricity from chemical energy.
Recommended experiment for informal assessment (1) Electrolysis of water and sodium iodide.	**A3** Lemon batteries and other batteries. Electricity from chemical energy.

(2) Find the Galvanic cell with the highest potential	
Recommended Formal Assessment [1] Experiment (Physics): Determine internal resistance of a battery.	**A5** Properties of solar cells- Voltage , current and power

(ii) Value of the Experimento 10 + kits

It is the general feeling amongst participants that the overall value of the equipment pieces in the kits provide them with easy accessible apparatus to set up particular experimental protocols. Participants appear to subscribe to an experimental approach to teaching, which is evident through the engaged and eager learners who appreciate the "Hands-on" approach as apposite to the "Talk-and Chalk" lessons that are mainly text-based and abstract. This is borne out by a comment from a teacher when she says that the experimental approach is **"extremely valuable because of the experimental nature of science. The children understand better if they can experience it".**

Learners find that interaction with the equipment is exciting, cognitively understandable as they make conceptual as well as contextual links under the teacher's facilitation.

(iii) Training in the use of the kits

The Deustche Schule Kapstadt, as one of the centers of excellence, provided their facilities and expertise to facilitate training to their cohort of selected in-service teachers and the method lecturers from the University of the Western Cape trained the undergraduate, postgraduate student teachers as well as in-service teachers at selected under-resourced rural schools. This intervention imbibed these key teachers with confidence and competence in managing the introduction of the resource materials to learners in a practical way thus developing conceptual understanding of the science knowledge base. However, it appears that a need exists for facilitators to avail themselves to on-site assistance to teachers in their science classes from time to time, to observe, measure and advise them in implementing a learner-centered experimental approach to conducting science lessons in an efficient and effective manner.

(iv) Cascading model

Initial positive outcomes were observed by lecturer-facilitators. The participants showed an eagerness to share their experiences via demonstrations to those teachers at their school who could not participate in the training programme. Thus the key teacher idea translates into a cascading model of science knowledge and skills for new science teachers, especially those who are initiates starting at a school. Schools who received a donation of an Experimento 10+ kit, received experiential exposure in the use thereof. In this way trained teachers consolidated their own skills as they built capacity in untrained science teachers in the use of the kits.

(v) Classroom Observations

Based on our interactions with and observations conducted in classrooms, learners appear to love the fact that they can touch and feel the materials as they engage with it. A classic example to illustrate this is found in the Energy section, where they have to connect the solar cells in series and parallel and see how energy is used to run the electric driven motors. These nodal points

opened many areas of extended discussions and extensions into areas like technology.
In addition this particular experiment is quite engaging and illuminating as it deals with real life issues of using solar cells to generate energy; at home they see these large solar panels generating energy to heat up their water in geysers, and in the kit they can see them in action on a miniature scale.

Spatial modeling is examined and therefore forms an important visualizing experience for the learner. Similarly the same observation is true for many other experiments contained in the Experimento 10+ kits, such as the generation of electricity using the lemon battery and the electrolytes from pickled cucumber liquid, thus concretizing concepts of electricity in a simple yet novel way.

(vi) Teaching model for large classes

The teaching strategies proposed in the program are indeed useful to adapt when faced with large numbers of learners in South African under-resourced schools, where learners in classes range from 40 to 60 at a time. Teachers however still need to adapt to using group teaching strategies to more effectively move learner groups from station to station. Time management ("time on task") is therefore required. Overall, teachers appear to manage the experimental practical process well, especially when using these resources.

(vii) Translation challenges – English to Afrikaans to isiXhosa

One of the main challenges mentioned by teachers was language. The Western Cape Language policy allows for three mother-tongue languages to be prevalent in schools and as from 2014 all three languages will be phased in from Grade 1, namely English, Afrikaans and isiXhosa. Prudently a continuation challenge would be the translation of English text to Afrikaans and isiXhosa in order to accommodate multi-cultural science classrooms in order to provide language equity in the science classroom. Teachers tend to complain of administrative overload and therefore do not have space and time to develop authentic translated activities with the same language rigor, quality and conceptual validity.

(viii) Re-stocking of consumables

The consumable materials would due to frequency of use become depleted and re-stocking become essential for sustainable implementation of the experiments. Therefore part of the training programme should consider recommendations in this regard.

6. Recommendations for the way forward

Phase one of the evaluation programme was completed in the mandatory six months, where localities were established, initial courtesy visits and workshops conducted with follow-up sessions and collection of qualitative evaluation data. Due to study extensive programmes, exams, teaching practice sessions and inspections at schools, comprehensive classroom observations are incomplete. These classroom observations are essential to obtain a critical lens with which to critique the success or otherwise of learner interactions with the Experimento10+ material in question as well as the efficacy of our key teachers in implementing the practical experience. Also the competence and conceptual understanding of concepts by learners in the South African context requires rigorous observation.

Furthermore, a salient point to consider is the writing of instructions in a language that learners understand. Thus translations should be considered and this is where our key teachers can assist with dialects and correct connotations of words in the official languages (Afrikaans and isiXhosa) other than English.

Our pre-service UWC-SSME teachers have not had the opportunity of linking with the Deutsche Schule Kapstadt, to experience an alternative laboratory experience at a German School of Excellence as suggested in an extension to this collaborative project.

With an early planning start to 2014, we believe that the project will be extremely valuable as a guide and model to envisage roll-out in other provinces and specifically with the agreement reached with the National Department of Education.

This proposal for the Way Forward is of course covered by the Second Trench Payment of 50% funding and can be executed within the Second Six months of the project (January 2014 to June 2014).

Now that the project initiation challenges have been identified, the Second Phase should flow more easily. In fact this pilot model for implementation identifies the pitfalls in the second semester of a scholastic year that is challenged by teacher whole school evaluation, preparation for matric exams, Annual National Assessments (ANA), task team evaluation amongst others.

We believe that this evaluation process is not just about science in the classroom, but about managing the science in the classroom through using Experimento10+ kits advantageously amidst all the other formal and informal school activities.

UWC-SSME is committed to take this initiative forward and we anticipate an exciting 2014 through our engagement with Siemens Stiftung and its' representatives. The year 2013 has seen favorable support for this initiative and through collaboration, Experimento10+ kits can be adapted linguistically ensuring its sustainability through adaptation and modification to the South African science curriculum in anticipation of a national roll out.

7. Appendix

Addendum: A

Table of Alignment of CAPS to Experimento10+

Grade 8 Electricity	Material included or Material to supplement	Experiment In Experimento10 +
Term 3		
Electrical energy/ Charges/Circuits/ Static electricity Cells/batteries as chemical systems - Resistors in series and in parallel - Effects of a current: - Electrolysis of Copper II Chloride - Light energy and the visible spectrum - output device: beeper, buzzer, LED, motor - input device: photocell	Static electricity Electric circuit: Conductors, resistors, Light bulbs, LEDs, Series and parallel circuits. electrolysis	**A 5**. Properties of Solar cells - Voltage, Power and current **B 6**. Renewal energies – Sun, water, wind, hydrogen and fuel cells.
Grade 8 Matter and Materials	**Material included or Material to supplement**	**Experiment In Experimento10 +**
Term 4		
Three states of matter	e.g. water (gas, liquid, solid) boiling point, melting point	**A2**. We store heat. From heat store to molten salt
Compounds and elements Difference between mixtures and pure substances	Decompose water into H_2 and O_2 by electrolysis - Test for H_2 and O_2	**B6.** Renewable energies – sun, water, wind hydrogen and fuel cell
Elements react to form compounds: Chemical reaction results in a different substance (compound) being	Reaction of zinc and iodine to zinc iodide Electrolysis of zinc iodide	**A1.** Electric current from solar cells – a dye sensitized solar cells. (to supplement)

formed Reactants: substances that react with one another Products: substances that are produced in the reaction.		

Grade 9 Matter and Materials	Required Equipment	Material included or Material to supplement
Term 1		
Important chemical reactions: Metals and non-metals with oxygen	magnesium Candle beaker	
Metal oxides and Non-metal oxides	Magnesium oxide Carbon dioxide	
Term 2		
Important chemical reactions: Acids and Bases		
Reactions of acids with - metal hydroxides, - metal carbonates - metals		
Reactivity of metals	Multi-plate, zinc, magnesium, copper Hydrochloric acid,	Magnesium, Zinc and Copper react with hydrochloric acid

Extracting metals from ores	Copper carbonate/ malachite Gas burner, test tube charcoal	From malachite to copper
Renewable and non-renewable resources (Matter and Energy)		

Grade 9	Material included or Material to supplement	Experiment In Experimento10 +
Term 3		
Forces (e.g. Magnetism)	Magnetic field, iron filings	**B 3** How does waster separation work? Separating materials by density and magnetism.
Cells as chemical systems and sources of energy	LEDs, copper, zinc	**A 3**. Lemon batteries and other batteries. Electricity form chemical energy.
Cells connected in series and parallel/voltages and current	Cells in series/parallel to LED	**A 3** Lemon batteries and other batteries. Electricity form chemical energy.

Grade 10	Material included or Material to supplement	Experiment In Experimento10 +
Term 1		
Do experiment with paper chromatography to show that water soluble ink-pens or —Smarties are not pure colours, but are mixtures of colours	Paper Chromatography	**B 4** We produce drinking water. Methods of purifying water.
Test copper, lead, aluminium, zinc, iron, sulphur, carbon, iodine, graphite and silicon to determine whether they have metallic, metalloid or non-metallic character. How are these elements used in industry?	Testing electrical conductors	**A5** Properties of solar cells- Voltage , current and power.
Test the following substance to classify them as heat conductors, or insulators: glass, wood, graphite, copper, zinc, aluminium and materials of your own choice.	Testing heat conductors	To complement
Test the following substance to classify them as magnetic, or nonmagnetic: glass, wood, graphite, copper, zinc, aluminium, iron nail and materials of your own choice.	Testing magnetic materials	**B3**. How does waster separation work? Separating materials by density and magnetism.
Start with ice in a glass beaker and use a thermometer to read the temperature every 10 seconds when you determine the heating curve of water. Do the same with the cooling curve of water starting at the boiling point. Give your results on a graph.	Heating curve Cooling curve of water	**A2** We store heat. From heat store to molten salt
TERM 1: Recommended Formal Assessment Experiment (Chemistry): Heating and cooling curve of water.	Heating curve Cooling curve of water	**A2** We store heat. From heat store to molten salt
The electrolysis of water (sodium sulfate added) to give products. Identify the elements and the compounds	Electrolysis of water	**A2** We store heat. From heat store to molten salt

Grade 10	Material included or Material to supplement	Experiment In Experimento 10 +
Term 2		
Use apparatus for hydrogen combustion to burn hydrogen in oxygen. Is this a physical change or a chemical change? (Explain)	Hydrogen combustion Test for hydrogen	**B6** Renewable energies – Sun, water, wind, hydrogen and fuel cell.
Pattern and direction of the magnetic field around a bar magnet.	Magnetic field	**B3** How does waster separation work? Separating materials by density and magnetism.
Set up a circuit to measure the emf and potential difference and get learners to try to account for the discrepancy.	Circuit with batteries, resistors and multi meter	**A5** Properties of solar cells- Voltage , current and power.
Practical Demonstrations: Set up a circuit to measure the current flowing through a resistor or light bulb and also to measure the potential difference across a light bulb or resistor.	Circuit with batteries and resistors	**A5** Properties of solar cells- Voltage , current and power.
Prescribed experiment: (Part 1 and part 2) Part 1 Set up a circuit to show that series circuits are voltage dividers, while current remains constant.	Circuit with batteries, bulbs and multi meter	**A5** Properties of solar cells- Voltage , current and power.
Prescribed experiment: Part 2 Set up a circuit to show that parallel circuits are current dividers, while potential difference remains constant.	Circuit with batteries, bulbs and multi meter	**A 5** Properties of solar cells- Voltage , current and power.

Practical Demonstration: Conversion of Energy (qualitative)	Conversion of Electric energy, light energy, chemical energy, potential energy, kinetic energy, heat energy	**A3** Lemon batteries and other batteries. Electricity form chemical energy. **A 5** Properties of solar cells- Voltage , current and power **B 6** Renewable energies – Sun, water, wind, hydrogen and fuel cell. **B7** Capacitor, hydrogen, redox flow – we store renewable energy.
Recommended project for formal assessment. The purification and quality of water	Separation methods to produce tap water	

Grade 11	Material included or Material to supplement	Experiment In Experimento 10 +
Term 3		
Recommended project for formal assessment: Investigate endothermic and exothermic reactions (Identify and explain the applications of exothermic and endothermic reactions in everyday life and industry)	Endothermic and exothermic reactions. Heat packs and thermometers.	**A3** Lemon batteries and other batteries. Electricity from chemical energy.

Grade 12	Material included or Material to supplement	Experiment In Experimento 10 +
Term 2		
Effect of catalyst – hydrogen peroxide and manganese dioxide; burning a sugar cube with and without dipping in activated carbon. Also adding a piece of copper to the reaction between zinc and HCl will accelerate the rate.	Catalytic reactions	**C 1** We burn sugar. Cellular respiration and breathing chain. **C 2** Carbohydrates as providers of energy for metabolism – Starch & sugar.
Determine the internal resistance of a battery.	Electrical circuit with a battery and multi meter	**A 5** Properties of solar cells- Voltage , current and power
Term 3		
Electrolytic cells and galvanic cells	Lemon battery Different galvanic cells	**A3** Lemon batteries and other batteries. Electricity from chemical energy.
Recommended experiment for informal assessment (1) Electrolysis of water and sodium iodide. (2) Find the Galvanic cell with the highest potential	Electrolytic cells Electrolysis of water Testing the potential between different metals	**A3** Lemon batteries and other batteries. Electricity from chemical energy.
Recommended Formal Assessment [1] Experiment (Physics): Determine internal resistance of a battery.	Electrical circuit	**A 5** Properties of solar cells- Voltage , current and power