Setlhare
science curriculum trust

M114 RADMASTE Centre
Marang Block
Wits School of Education
27 St.Andrews Road
PARKTOWN

P.O. Box 256 WITS 2050
Telephone: 011-717-3471
Fax: 011-717-3470

peter.moodie@wits.ac.za

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Report on the *Structures, materials and the nature of matter* courses, dealing with CAPS content for primary schools

Contents

Dates of the courses

The course was held on 4, 5, 11 and 12 March at the RADMASTE Centre, and again on 14, 15, 18 and 19 March.

The intended outcomes of the course

The intended outcomes are that participants are able to

- analyse frame or shell structures and explain how they have been stiffened or strengthened
- analyse the kinds of forces on structures
- process simple materials to make composite materials
- teach and manage a technology project that includes the aspects/moments known as Problematise - Investigate - Design - Make - Evaluate – Communicate
- describe and classify matter and explain changes in materials, at a level appropriate to teachers
- put themselves in the shoes of children who arrive in school with personal and private understandings of the world, such as the nature of air, or how evaporation occurs
- design and manage an investigation with a class in such a way that the children improve

their investigation process skills.

The course does not aim to take teachers through the CAPS content for each Grade for the second quarter; that would be impossible in four days. Instead, it assumes that if teachers understand the Grade 4-7 content from the scientific point of view, and from the children's point view, they will make good lesson planning decisions.

The activities and content in the course address each of the Learning Outcomes, now known in the CAPS as Specific Aims.

Specific Aim 1: 'Doing Science and Technology'

Learners should be able to complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutions. This means that learners plan and do simple investigations and solve problems that need some practical ability.

Specific Aim 2: 'Understanding and connecting ideas'

Learners should have a grasp of scientific, technological and environmental knowledge and be able to apply it in new contexts. The main task of teaching is to build a framework of knowledge for learners and to help them make connections between the ideas and concepts in their minds – this is different to learners just knowing a lot of facts. Discussion must relate to previously acquired knowledge and experience and connections must be made.

Specific Aim 3: 'Science, Technology and Society'

Learners should understand the practical uses of Natural Sciences and Technology in society and the environment and have values that make them caring and creative citizens. Issues such as improving water quality, growing food without damaging the land, and building energy-efficient houses are examples of everyday applications. Similarly, Science and Technology can lead learners to a range of career and job possibilities. An appreciation of the history of scientific discoveries and technological solutions, and their relationship to indigenous knowledge and different world views, enriches our understanding of the connections between Science, Technology and Society.

The key knowledge areas

1. **Structures**: frame and shell structures; the kinds of forces that structures must resist; how structures are made stiff; how structures are used in the built environment and in nature. Teachers should be able to apply techniques such as adding ribs, struts, ties, corrugations and rolled columns to stiffen and strengthen structures.

2. **Processing materials**: combining materials to create materials with new properties; composite materials; practical skills in processing materials and ways to manage such activities in an ordinary classroom. Teachers should be able to make flour paste, make

paper rods, apply *papier maché* to formers to create shell structures, include reinforcing materials to strengthen the structures, mix PVA with powder paint to create a varnished look to products, use hot wax to waterproof their structures, combine other material to make coloured wax, use dough to create a mould that can produce a 3D shape.

3. **Managing technology projects in a classroom**: the importance of the pupils "buying into" the situation of people with a *need or problem to be solved*; *investigating* the need, or existing solutions and factual knowledge, or suitable materials, or skills that will be required; *designing* a product that incorporates the investigations; *making* the product using tools and materials economically and safely; *evaluating* the product against the criteria that came from investigating the need; *communicating* at each stage the thought that goes into the project, by drawing and writing. Teachers should be able to complete at least one structure that meets specifications and ask appropriate evaluation questions. Teachers should also be able to look for evidence of a pupil's understanding in the completed model and be able to explain why the model itself should not be given a mark.
4. **The classifications of matter**: the multiple ways of classifying materials by their properties, but in particular the classification into solids, liquids and gases; the classification of solids into metals and non-metals; the classification of metals into magnetic and non-magnetic and the classification of non-metals into elements, polymers and ceramics. Teachers should be able to develop the pupils' language that they need to participate in discussions about matter and materials.
5. **Developing pupils' mental ability** to "conserve substance" (or to reason about substances) even when the substance (such as water-vapour) is invisible and undergoes changes that cannot be seen. Teachers should be able to ask questions that elicit the children's ideas about air or water-vapour, and be able to follow through with activities that challenge the children's non-scientific notions.
6. **The particle kinetic model of matter**: understanding the assumptions and use of the model/theory. Teachers should be able to apply the model to explain melting, evaporation, condensation, solidification, expansion and contraction in the cases of solids, liquids and gases.
7. **Mixtures and means of separating them**: the relevance of separation techniques in health, mining, waste reclamation and other kinds of industry. Teachers should know and be able to practically set up eight examples of separation methods spanning Grade 6 to 8 in the CAPS.
8. **Solutions and crystals**: solutions are homogeneous mixtures of one substance with one or more other substances; using the particle model to predict how a substance will dissolve in

another and how saturated solutions produce crystals of the solute. Teachers should be able to explain how the particle model explains the shapes of crystals and know methods of growing crystals.

9. **Factors that affect the rate of dissolving**: the temperature as a factor, grain size as a factor and stirring as a factor; how the particle model explains the effects of these factors; the design of two investigations in which temperature and grain size are independent variables; the value of a framework of process skills which enables teachers to ask good questions about ways to test hypotheses. Teachers should be able to manage the pupils' planning of an investigation, manage the actual activity, ask process-skill questions and expand the discussion of the results.

The methodology of the presentation

The approach is important. It would be possible to cover the knowledge areas above by means of slides, demonstrations, videos and printed notes. This could be done in about two mornings.

However, this approach would not address the intended outcomes and Specific Aims and it's very unlikely that this approach would promote practical work in lessons. The significance of practical work lessons is that pupils experience real matter and materials, and can talk about them and develop the language they need for thinking scientifically.

We all tend to teach in the way we were taught, so it's very important for a course leader to model the approach practically, with real equipment.

During the course I gave files with notes and referred teachers to them but seldom taught directly from those notes. Teachers are able to read for themselves, so it was better to use the time for interacting with the equipment and each other.

The course design

The course design is loosely based on Kolb's model of experiential learning – participants do an activity that we then analyse for new ideas or new problems, and then go into a related activity in which those problems can be resolved or questions answered. Linkages are made between activities across the four days so that there is some unity between key ideas, such as between the design of a structure and the properties of materials that could be used.

Participants write a personal baseline test near the beginning of the course and then re-write it on the last day. The teachers mark their own pre- and post- tests and can see any gains they have made.

On each day, participants do technology or science practical activities in groups of about three people, using mostly materials and equipment that can be bought from supermarkets or are clean, re-cycled materials. The number of activities range between between three and five on any of the four days. Extended discussion activities range between two and three per day. The course includes two short films of classrooms and two computer simulations of particle behaviour.

We try to make the point, by example, that a great deal of prac work is possible in an ordinary classroom and without formal laboratory equipment. We do not use a laboratory and work in an ordinary flat classroom with loose tables.

We do use a few pieces of equipment that must be bought from lab suppliers, such as copper sulphate, thermometers, Pyrex beakers and meths burners. Teachers will get contact details of such suppliers in their email newsletters. These suppliers include the RADMASTE Centre which develops the Microscience kits that were displayed.

Evaluation comments from teachers

By participants on the first run of the course, 4, 5, 11 and 12 March 2013

All remarks have been transcribed exactly as they were written, and any emphases were put there by the teacher who wrote the remark.

1. *The course was very nice. I really gained a lot of knowledge and practical skills that will use in my classroom. I wish I could attend more courses such as this one to remedy things which we teachers are not sure about.*
2. *The course was an eye-opener and I really learned a lot and my test scores are evidence of that. Doing the test at the beginning of the course and at the end is a fantastic idea. This course will help me make my lesson more practical and scientific. Well done for running a well-organised course that was fun and informative. :)*
3. *The course was well presented. I gained a clearer understanding of teaching the subject. Thank you Peter!*
4. *Things moved far too slowly and could have been condensed into 1 day. I would not recommend this course.*
5. *Teachers who are <u>new</u> to teaching science will find the course stimulating. It has helped me understand how to convey specific concepts to my classes. The availability of useful sites from the internet is invaluable to the "new" teacher.*
6. *I was a little disappointed with the course as I thought there would be more about CAPS and the integration of science and technology.*
7. *I feel that you could condense the course and then cover even more but I did enjoy what you did cover. Some of the practical work was a little too basic and could have been done without being covered by the whole class.*
8. *I thoroughly enjoyed the course. I was good to do group work with people I did not know. Peter was patient and entertaining and good at making suggestions to help us solve problems. Some sections were drawn-out. I think the course could be completed in 3 days. I have gained much from the course and would recommend it to others. Thank you.*
9. *My only issue was that the pace of the course could have been quicker and more work covered in a shorter time period otherwise very interesting.*
10. *Thank you for your hard work. I now feel very positive about the CAPS.*
11. *The course was an eye opener in many aspects and I especially liked the improvisations used: shows how science can be taught with everyday materials.*
12. *I feel that the course could have been put into 2 days. I gained a lot from it but 4 days out of the classroom is too much time. Thank you. Louise.*
13. *I thoroughly enjoyed the course and feel much more confident to teachers science and technology (especially tech as I haven't done it before). The <u>pace</u> was good and allowed for lots of discussion. Which is what children would like. The practical activities were excellent. Peter has shown us how to teach certain concepts using very simple materials. Many courses are too involved in theory – we need to be shown how to teach these concepts. Well done & thank you.*

Comments from participants on the repeat course, 14-19 March

14. *I learnt a lot from practical, teaching and mostly enjoyed the video. I would be happy if you may send us the video for us to watch. If it is possible again may we please receive a kit/ gift to use in our classes e.g. microscope if others you add it in the fees or something. Also the facilitator to do something about those who talk during his teaching as it disturbs others*

that are interested. May we be firm, strict to those please? We are adults.

15. *Quality and effective teaching take place. Gained a lot of science information and written and practical exercises.*
16. *It's a very good course, it should continue to run.*
17. *I was excited and felt satisfied. The environment was friendly; lessons were well explained and interesting. I felt happy because I learned more concepts and teaching skills. Excellent job. Thumbs up from me.*
18. *A worthwhile course which has helped me deepen my understanding of CAPS. The atmosphere was friendly and allowed all of us to participate freely. The cost of science kits should be included in the payments.*
19. *Course was well outlined. The facilitator had vast knowledge about all concepts delivered, members had time to be in groups and be hands on with designing structures that made our understanding and way of dealing with problems be more intense, above all, the course was well outlined and met my expectation. NB The timing of programme was not favourable as we were under severe pressure with school reports.*
20. *Course was well presented most of the activities were clear to me also the content of the CAPS as it was my first time to teach the NST in grade 6. Next time we humbly ask the CSO to look on the time frame e.g. when we attend on the second term it must be earlier before the learner's exams.*
21. *The course was fruitfully worthwhile although we attended for two days only due to lack of communication between the principal and the educators. So I would suggest the CSO should address the mail to the teacher in particular not to the principal example Mrs Kunene to attend a course etc. sometimes you feel deprived deliberately or is it ignorance or mismanagement.*
22. *The course was very practical and I learnt a lot from the activities which we did.*
23. *Well structure programme with effective technique of relying the content of the course. Being practical, made it fun but all reinforce the purpose of each lesson. Tea and lunch was well done. Thank you for inviting our school.*
24. *The course was brilliant and stimulating!!*
25. *The course was practical for me as is my first time doing NST. I like the way Peter explained to me I enjoyed a lot and makes me like NST even more. I wish he could visit my school to explain more to our kids, St John Berchman's.*

Reflection on the first course and the repeat course

Each group had its own dynamic. In the first group about 5 out of the 16 teachers felt there was too much discussion time, or topics for discussion were passé, or the activities were not challenging enough. However, we did manage to do almost all the intended work. In the second group, activities which I expected to be completed quickly went on much longer because the teachers were intensely involved, and ignored my deadlines.

Teachers who are established in well-administered schools may have less sense of uncertainty about what the children actually believe about a topic or whether a topic should be handled in a different way. A course such as this needs to take account of that and find novel approaches to issues like children's talk, or the value of process skills or real-world applications.

The issue of children doing more writing as a means to improving their reasoning, remains important, but we did not get to grips with it. The course needs more stimulus material from children, for teachers to bite on.

The materials-processing activities (using papier maché over formers, water-proofing them with wax, coating them, or making moulds and casting wax) were surprisingly popular, considering that primary school teachers presumably do activities like these quite often in creative arts. It seems that at least this aspect of technology should cause teachers little difficulty this year.

In the repeat course, the majority of the teachers were from 4-term schools. Since their schools were closing on the 20th at least three of the teachers needed to leave early on the last two days, to get back and complete reports and other admin.

Revisions to future courses

We should avoid dates that place the course near exams or term-end days.

Teachers might prefer shorter courses that deal with content their Grades will be covering, instead of a course like this that attempted to deal with major themes from Grade 4 through Grade 7.