

science teacher

2011

Featuring: Model IT

Problem-based learning

Modelling Eocene climate

Forecasting the weather

Optimising solar
radiation collection

Junior Café Scientifique

Reading to learn
in science

Magic of quantum
mechanics

Modelling in science
education

Modelling fluid splashes

Southern Ocean
carbon cycle

And more...



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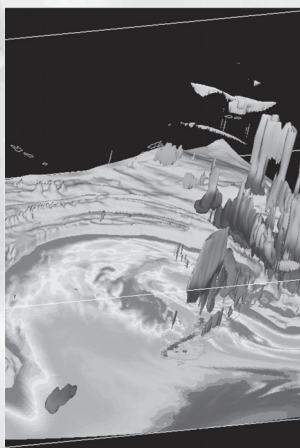
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Front cover: A section of the NZLAM forecast system domain for 12 noon on 15 Feb 2004 (during the severe weather event over the lower North Island), visualized in 3 dimensions, showing a) specific humidity at the surface (red indicates high, and violet low values) and an iso surface aloft, b) regions of updraft and down draft coloured according to the potential temperature, and c) isobar contours of pressure (Pa) at 6.1 km altitude. Courtesy of NIWA. For more read: *Forecasting the weather* (p.23).

Editorial 2

From the President's desk 3

Feature: Model IT

Modelling Eocene climate **4**

Magic of quantum mechanics **7**

Modelling fluid splashes **12**

Detecting changes in the Southern Ocean carbon cycle **15**

Modelling horticultural produce storage and packaging design **18**

Optimising solar energy collection **20**

Forecasting the weather **23**

Science Education

Problem-based learning in science **28**

Reading to learn about birds and their conservation **31**

Junior Café Scientifique **34**

Coastal adaptation to climate change **37**

Science/Science Education Interface

Conversation: Modelling in science education **11**

Conversation about polymaths and data deluge **45**

Primary science

iPod Touch and science teaching **40**

Nature of science activity **41**

Mr Science – Part 2 **43**

Subject associations

Chemistry **44**

Physics **46**

Women in science conference **46**

ESSE **47**

Technicians **48**

coastal adaptation to climate change

Students, teachers and environmental scientists collaborate in identifying and addressing coastal adaptation to climate change issues as Anne Hume from University of Waikato, Paul Scott, Jan Murgatroyd, Svargo from MBAS, and Terry Hume and Rob Bell from NIWA explain:

Background

This article reports on a successful collaboration between students, teachers and environmental scientists at Mercury Bay Area School, Whitianga, seeking to find solutions to problems associated with coastal adaptation to climate change. The resulting cross-curricular study in a Year 10 class, "...has made the students appreciate that they can have an impact on the environment and the things they value," (Jan, teacher, MBAS).

Introduction

Over the past two decades unprecedented development of the coast for holiday and permanent homes, along with tourism and associated facilities such as marinas, has resulted in a dramatic rise in the risk of coastal flooding, erosion and habitat change associated with sea level rise and climate extremes. The National Institute of Water and Atmospheric Research (NIWA) and its partners received a three-year grant in 2008 from the Foundation for Science Research and Technology (FRST) to create the necessary information and tools to enable adaptation by central and local government and communities to the impact of climate-induced change on the coastal environment. A team of environmental specialists including scientists, engineers, planners, social scientists and educators, along with support from Environment Waikato and Thames-Coromandel District Council, was brought together as part of the *Coastal Adaptation to Climate Change* (CACC) programme. A strand of the work involved engaging with the community of Whitianga to raise the awareness of the issues and risks and consider adaptation strategies for the local situation. Whitianga is a township on the eastern coast of the Coromandel Peninsula, which lies to the east of Auckland city in the North Island (see Figure 1).



Involvement of the school community

The CACC project team saw the local Mercury Bay Area School (MBAS) as an important contributor to this community-based initiative since school pupils are likely to experience the effects of climate-induced changes to their coast in their lifetimes. The chances were also high that these same students would have responsibility for making decisions in the future about how the Whitianga community might respond and adapt to these coastal changes. Thus, the school was invited to collaborate with the team to help the Whitianga community begin thinking about how to address these issues. An initial meeting was held between Paul Scott (joint head of the Science Department), and members of the project team to 'test the waters' and gauge how interested Paul and his fellow teaching staff might be in designing and delivering a cross-curricular unit for the middle school (Years 9–10) around the theme of adaptation to climate change. With assistance from teachers and scientists, students would have the opportunity to learn about the risk of coastal flooding, erosion and habitat change associated with sea-level rise and climate extremes and develop solutions to issues faced by their community related to future climate change and coastal adaptation.

Project goals and NZC

The New Zealand Curriculum (NZC) [MoE] guides the development of schools' teaching and learning programmes from 2010 onwards and promotes a future where young New Zealanders emerge from schooling as confident, connected, actively involved and lifelong learners. The CACC team believed a cross-curricular unit around the theme of coastal adaptation to climate change had the potential to embrace many of the guiding principles and values that underpin this national curriculum and could help students meet these aspirations with:

- a community-based learning context that has relevance and meaning for them
- ways and means of identifying and addressing a future-focused issue in their community that involved ecological sustainability and citizenship for the common good of all people
- opportunities for community engagement in scientific activities that respect and complement local iwi histories and traditions, and encourage connectedness to the land and environment.

The unit also addressed specific requirements of the new curriculum, namely that "links between learning areas should be explored" (p.39).

As things eventuated, the invitation to develop such a cross-curricular unit was very timely for MBAS since it gave the teaching staff the opportunity to trial a pedagogical approach they had been exploring which was closely aligned with the goals of the recently implemented NZC (MoE, 2007). This project-based approach, known as 'Understanding by Design' (Wiggins & McTighe, 2004), supports teachers in developing learning and assessment with a focus on deepening students' understanding of important ideas. It also promotes inquiry-based learning through authentic problem-solving learning in contexts of genuine importance and relevance to students.

Learning outcomes are identified as *knowledge* (which can be short-term), *skills* and *understanding* (which are more likely to be long-term). Key to the approach is transformative learning where learners develop enduring



Educating the public about coastal processes at the MBAS Enviro-showcase.

understandings and come to ‘see things in a new light’. Cross-curricular input is essential for this project approach to work – a strategy strongly advocated by the new national curriculum. The real world context of coastal adaptation to change, the opportunity to work with other teachers across the school curriculum, and access to the collective expertise of the CACC team made this collaboration very attractive to the teachers, and so the school and staff accepted the invitation to be involved.

Community Open Day

A month later four teachers from the school attended a public Open Day on the topic of climate change and coastal adaptation run by the CACC project team in the Whitianga Town Hall. The Open Day exposed the public to past effects of climate change on the Whitianga environment as they walked through a photo gallery ‘time tunnel’ showing coastal flooding, storms and erosion. The public also participated in identifying the things they value about their environment (such as where they walk, kayak, launch their boats etc.) by placing pins and notes on large aerial photographs of the Whitianga area which showed where the coastal flooding erosion and habitat changes will occur in the next 50 years.

At a subsequent follow-up workshop, members of the CACC team explained to the public and the teachers how climate change is likely to affect the temperature, sea level, coastal erosion and flooding, the frequency of storm events and habitat change in the estuary, and also provided some options to combat these effects. The audience questioned the information and participated in debate on the issues. Then, in a workshop activity, participants discussed and made recommendations about strategies for minimising the adverse effects of climate change on specific areas of the Whitianga community such as the beach front or the estuary and things they value.

Each activity group had a member of the CACC team available to answer technical and/or scientific questions. The MBAS teachers found the day very stimulating and many potential ideas for their teaching unit began to crystallise. Paul (science) commented in a later interview that he took this opportunity to explore the complexities of climate change and ‘distil some key understandings.’

Planning with CACC

At a follow-up joint planning day with CACC team members, the teachers described how they intended to approach the teaching and learning of the unit and what aspects they needed specialist help with. As mentioned earlier, the teachers had opted for a programme of learning where students would work together to produce a solution to a complex, real-world problem: that is, how to mitigate the



Student scientists ‘getting up close’ with beach features and processes.

impact of climate change on their local environment and community.

In the ‘Understanding by Design’ model (Wiggins & McTighe, 2004) planning is done using ‘backward design’, where teachers first establish *broad learning goals* and *tangible outcomes* before more specific planning of what and how learning is to occur. In this unit the overall learning goal was to raise student awareness and understanding of the need for adapting to climate change on our coast. Outcomes included: a student-designed and performed survey of the community’s current understanding about the need for coastal adaptation to change; recommendations to help protect the things their community values that are under threat from climate change; and a display of their findings at the school’s annual ‘Enviro-showcase’ in September which was open to the community. The teachers had begun work on other phases of the planning process:

- identifying the *enduring understandings* students would need to achieve the goals and how these big ideas might be developed
- asking *essential questions* (who, what where, why, when and how) to help focus on the goals
- asking deeper philosophical questions (who should, how would, what might, where might) to guide future actions
- identifying the *knowledge* and *skills* required to support development of the enduring understandings.

As they described their intentions for the unit the teachers began articulating their own learning needs and what input they needed from the CACC team to teach the unit. This input often took the form of answers to specific questions concerning the science of climate change and likely scenarios. The teachers also sought information sources such as raw data on water temperature and sea level measurements in and around Whitianga, which the CACC team undertook to supply.

Armed with this information the teachers set about finishing the planning of the unit and sorting out the logistics such as timing of classroom sessions, the field trip and teaching materials. When implemented, the unit was taught to a mixed ability Year 10 class for a seven-week period during Term 3, averaging 14 hours per week spread over Science, Mathematics, English and Social Studies timetabled classes (approximately 100 hours in total). Science occupied 28 hours of teaching time over a six-week period. Details of the teaching and learning sequence and students’ learning activities can be found on the school website at: <http://www.mbas.ac.nz/>.

Reflections on the experience

On reflection the teachers found the cross-curricular

teaching was not without its difficulties, but on the whole very rewarding for staff and students. Jan (social sciences and English) enjoyed working with her colleagues and having the CACC team on call for their expertise and understanding. Paul (science) felt the unit helped teachers to make connections between the disciplines. He also commented, "Collaborative units are time-consuming and exhausting, but now it is in place it was worth it. The enduring understandings were in place before we started the unit but it was a case of developing learning tasks/ materials as we went so that they would help students to understand the concepts. A lot of flexibility was required."

One strategy that worked particularly well was the use of student folders that travelled with them in a box from class to class. These portfolios of cross-curricular activities covering aspects of science, mathematics, English and social sciences helped students to organise their learning materials and gave continuity to the study. The contribution of the CACC team was strongly evident in these activities, from the use of NIWA information sheets and data to the survey information about community values gathered on the public Open Day. Highlights for the students included the chances to study the beach firsthand and build models for the 'Enviro-showcase'.

The teachers emphasised that while some outcomes of the original planning did not eventuate – like the survey of community understanding of climate change and coastal adaptation – the processes were just as valuable for learning, and this is reflected in their in-school survey on people's values and perspectives of coastal defence systems. The 'Enviro-showcase' did require students to use their knowledge to inform the community about values, how climate change will affect them and what strategies can be used to combat, for instance, coastal erosion which they did via PowerPoints and models. Students learned from each other building their models for display, and interestingly, their construction decisions were often based on where they lived. For example, students who had rock wall protection on the beach front in front of their homes placed a wall in their model, whereas those with dunes in front their homes featured dunes in their model.

Promoting higher level critical thinking

The decision to introduce the Geography Achievement Standard 1.6 *Examining a contemporary geographic issue* into the unit as a summative assessment caused some discussion amongst the teachers, and some were worried it may be too difficult for their students. However, the standard developed by Tony Nelson (HOD Social Sciences) did give some students the opportunity to demonstrate some very high levels of critical thinking.

In the assessment, students were to read a fictitious newspaper article entitled "Coastal Management and Erosion at Buffalo Beach" that reported on the recommendations of a scientist employed by the regional council to investigate erosion in the area and how to prevent it. The article outlined the scientist's proposal for the construction of an artificial dune and the reactions of various members of the local community to this proposal like individual beach residents, the Buffalo Beach Residents' Association, the local surf club and a representative of the local iwi. A series of tasks followed that focused on:

- selecting and examining economic, social and environmental aspects of coastal management and erosion at Buffalo Beach
- examining the viewpoints of people towards coastal management and erosion at Buffalo Beach and providing reasons why different people may hold their viewpoints
- evaluating the strengths and weaknesses for three possible courses of action for preventing erosion at

Buffalo Beach, such as the use of the experimental dune, groynes, rock cages, doing nothing or locals taking their own action.

The students did find this assessment challenging, but some were able to achieve the standard, which was very gratifying to the teachers since it assessed understanding at Level 6 of the NZC. A few achieved at merit level by successfully identifying the strength and weakness of various options. For example, one student pointed out that while groynes (low rock walls that run from the dunes to the low tide level to trap sand driven alongshore by the waves) might be relatively cheap and don't reduce access directly onto the beach, they do affect access along the beach in emergencies and can starve the beach of beach material (sand) with detrimental effects.

Final thoughts

Paul (science) summed up the learning experience for students as follows: "What I would like to see from now on is that when our young people walk along the beach they see the world through different eyes. I don't know that this has been 'transformative learning' as such. The students didn't hold any strong views or have a very conscious frame of reference at the beginning of this unit. (I don't think we have destructed any previous knowledge or understanding, rather, we have built knowledge and understanding). But what we have attempted to do with the learning tasks that we have provided is to take them step by step on a journey in which they have come to an understanding of the complex process involved if communities are to actively adapt to change. I think that our students have developed an understanding and are more likely to have the confidence to enter the coastal adaptation debate. I feel we have been able to grow advocates for the environment; it's not the erosion that is the 'problem' it's human development! We have unwittingly developed houses and roads in a natural environment that is constantly changing."

The positive experience of teachers at MBAS for this collaborative, cross-curricular approach has prompted them to make their unit available to other New Zealand school via their school website. The unit is called 'Coastal Adaptation to Climate Change'.

The CACC team impressions of the benefits of the collaboration are best summed up in the words of Dr Terry Hume (NIWA): "It was a very rewarding experience for the project team to observe the way the teachers met the challenge of distilling complex scientific concepts of coastal processes and climate change into information the pupils could understand and relate to. Cross-curricular learning is a very logical learning methodology for students who one day will need to address environmental issues which are best addressed through an interdisciplinary approach. A personal highlight for me was seeing MBAS students at the NZ Coastal Society Conference in Whitianga proudly showing off their PowerPoint presentations and models of the Whitianga beach front prepared as part of their course work to members of the science, planning and engineering fraternity."

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