TEACHING & LEARNING
RESEARCH INITIATIVE
NĀU I WHATU TE KĀKAHU, HE TĀNIKO TAKU

PO Box 3237
Wellington, New Zealand
**Email:** tlri@nzcer.org.nz
**Website:** www.tlri.org.nz

Bronwen Cowie, Judy Moreland, Alister Jones, and Kathrin Otrel-Cass

# The Classroom InSiTE Project: Understanding classroom interactions to enhance teaching and learning in science and technology in Years 1–8

> What really counts in education is what happens when teachers and students meet. The wisdom of any decision about education is best judged on the basis of whether or not it raises the quality of these interactions. (Atkin and Black, 2003, p. ix)

A significant goal of the Classroom InSiTE (Classroom Interactions in Science and Technology Education) research project was to develop a more robust understanding of, and to enhance, classroom interactions as a key aspect of assessment for learning (AfL) interactions. International research suggests that AfL practices are effective in enhancing student achievement, and may be particularly effective with students who are low achievers (Black and Wiliam, 1998). AfL can be distinguished from other forms of assessment by its purpose, which is to enhance student learning. The contingent and emergent nature of AfL means that it is generally embedded in and accomplished through teacher–student classroom interactions.

For teachers, undertaking AfL is demanding and complex. To assess and respond to student learning, teachers need a detailed understanding of possible student learning pathways, along with the ability to develop and deploy pedagogical strategies to ascertain students' current understandings and to move their learning forward. The blending of teacher content knowledge and pedagogical knowledge to a form appropriate for their particular students is commonly referred to as pedagogical content knowledge (PCK) (Shulman, 1987). New Zealand primary teachers have indicated that they can lack confidence in their ability to teach science and technology and that they are interested in developing their practice in these areas (McGee et al., 2003). This project built on that interest.

A sociocultural perspective towards learning and pedagogy underpinned the InSiTE study. Sociocultural perspectives are increasingly being used to make sense of classroom teaching and learning because they acknowledge complexity and the impact of interactions between people, ideas, tools, and settings over time (Wertsch, 1998).

## Research aims and objectives

The project involved working with teachers and cohorts of students in Year 1–8 classrooms to investigate and to identify over time:

- subject ideas that teachers perceive as important for student learning in science and technology
- pertinent teacher PCK, its sources, development, and the ways it is embodied in teacher–student interactions
- the structure of interactions around science and technology ideas, the factors that afford and constrain interactions and the implications of this for the construction/ constitution of what it meant to know, do, and understand science and technology
- student and teacher perspectives of interactions that support learning
- the temporal aspects of the teaching and learning science and technology as these play out for student learning (including conceptual, procedural and attitudinal outcomes)
- student understandings of the nature of science and technology.

## Research design

To address the research aims, multiple methods of data collection were used. Student and teacher reflective interviews; and teacher and researcher joint planning, reflection, and data analysis meetings complemented the classroom work. Classroom work and teacher and researcher team meetings alternated throughout the three years. The classroom data-generation methods were videos of teacher interactions with students; audio taping of teacher and student talk; field notes and photographs of class work; and collection of teacher documents, student work, and lesson materials. Postlesson teacher–researcher discussions and team meeting days provided a forum for joint data analysis.

## Findings

Over the course of the study the research focus evolved. The key findings reported here reflect that evolutionary process.

### Enhancing pedagogical content knowledge

The project highlighted the importance of working with primary teachers to identify, articulate, and build their science and technology PCK. Teachers need to employ an intellectual process to translate their content knowledge into forms learnable for particular students and to transform generic pedagogical practices to help their students learn science and technology. The use of a two-part planning framework supported this process. The first part of the framework focused the teachers on analysing their own understandings and articulating possible student learning goals. The second part of the framework prompted the teachers to formulate science- and technology-specific teaching approaches and tasks. Cycles of using the framework to plan and reflect enabled our teachers to anticipate student learning difficulties, to translate their science and technology content knowledge into outcomes that were learnable for their students, and to design and prepare tasks to support student learning. Teachers' science and technology PCK was further developed when they used these plans in their classrooms. It was then that they put their PCK into action, especially in their AfL interactions with students. The teachers' science and technology PCK was further refined when they reflected on what had occurred in the classroom in relationship to what they had anticipated when they planned. At the conclusion of the project our teachers reported they were more certain they could tease out relevant concepts and principles when interacting with students. They considered their interactions with their students were more focused and productive when they had a better appreciation of what they wanted their students to learn and how this might be promoted.

### Classroom interactions in primary science and technology

The multimodal nature of interaction emerged as a key focus for the project. Attending to the multimodal nature of student interaction around ideas and practices provided a rich entry point into developing student ideas. Teachers providing multiple and multimodal opportunities for students to articulate, explore, and refine their ideas increased the likelihood that a diversity of students would be able to do this. The teachers made active use of tasks that provided students with multiple opportunities to make and express meaning through a combination of modes—drawing, talking, writing, action as modelling, gesture and dramatisation, and the use and production of artefacts. Through multimodal interactions student and teachers were able to negotiate a shared understanding and teachers were able to provide rich feedback and guidance. Science and technology provide authentic contexts to explore the use of the visual in conjunction with, and as an alternative to, text (oral and written). While talk of new literacies has tended to be located in the English curriculum, science and technology curricula have a contribution to make in this area.

Artefacts, those brought into the classroom from home (sample objects, such as fossils or kites) and those designed by teachers (such as handouts or posters), provided a scenario and resources for interaction. Sometimes they anchored talk, and augmented it, and at other times they provided an alternative. In whole-class settings publicly visible and accessible artefacts provided direction, guidance, and support for interactions between students across different locations and time. Artefacts conscripted students to work together in small-groups settings; they provided guidance in the absence of the teacher. The influence of an artefact on interaction was not a given; rather this depended on how it was introduced to the students by the teacher and how it came to be integrated into interaction. Over the course of the project the teachers, as they came to appreciate the effect of artefacts, paid more attention to the form and function of the artefacts they used. The use of real objects in particular helped teachers to elicit student prior knowledge and experiences that could then be used as a resource to expand the pool of ideas available for public discussion.

Each of the InSiTE classrooms provided a distinct social setting for interaction. Teacher and student routines for working together influenced with whom, how, and with what effect different individuals and groups interacted with each other and the teacher. Regularly used routines carried important messages about how learning was to be conducted, particularly since they pervaded every aspect of the lessons we observed. These routine aspects of interaction conveyed implicit messages about the nature of scientists' and technologists' work, including how these communities warrant what counts as valid and valued knowledge. The InSiTE teachers used a number of practices that served to distribute authority and support student autonomy and agency. These included according value to student ideas and experiences, and those of their family and friends. The teachers seeded the classroom environment with artefacts including books, posters, and other materials that distributed authority. They used tasks with varying degrees of openness, often increasing this as their students became more knowledgeable and proficient. The teachers allowed students free access to peers for help. These strategies opened up different opportunities for students to initiate interaction and supported different forms and levels of student autonomy and agency.

### The temporal aspects of teaching and learning science and technology

Teachers are responsible for supporting their students' learning in the moment, over the duration of a unit, and over the course of the school year. The InSiTE teachers acted to provide a sense of continuity and coherence within and across ideas, tasks, and lessons. The continuing and connecting actions they used were at times particular artefacts, which provided platforms of continuity for developing skills and deepening thinking. Continuity was also supported through teachers articulating the ways individual tasks fed into the bigger learning objective. Teachers supported students making connections by talking about the links and connections between ideas and tasks. Students demonstrated their learning when they obviously changed their ideas and increased their skills. They demonstrated the connectivity in their learning when they linked past experiences and prior ideas to a present situation.

### Student perceptions of the nature of science and technology

Sociocultural views of learning emphasise that students' learning in science and technology involves students learning about what it means to be a scientist or a technologist and how they conduct their work, in addition to learning content and practices. Students needed to be explicitly introduced to ideas of the nature of science and technology for them to develop this understanding. In classes, the InSiTe teachers explicitly detailed aspects of the nature of science and technology, enabling students to make comments such as "science is about experimenting", and technology is "inventing things, changing, modifying, new ideas. It could be your job." The early years teachers also positioned their students as scientists or technologists to add authenticity and meaning to tasks. Students readily identified with this approach.

## Partnership between researchers and practitioners

One of the goals of the TLRI is that teachers participate in the projects as teacher-researchers. Although there are many meanings of this term in the literature we do not consider that the way we came to work as a team of teachers and researchers resulted in teachers taking up a role as teachers as researchers in the full sense. Rather, we conceptualised our joint involvement as a partnership in which teachers acted in support of the research process and researchers acted in support of the teaching and learning process. We participated as equals who had different and complementary knowledge and experience, thereby enriching the research process and any possible benefits deriving from the project. Working this way helped us to maintain a focus on the how, what, and why of interaction, PCK development and student learning pathways.

## Limitations of the project

We set up the project as a three-year longitudinal study in anticipation that it would be possible to trace teacher and some individual student learning over this period of time. In the event, some of the teachers took up other opportunities during the time of the project and it proved impossible to trace the same students across the full three years. The location of science and technology as outside the core of the primary school curriculum proved to be a constraint on the project: science and technology were not often taught more than once or twice during a year, which led to issues around scheduling classroom work and a sustained development focus within each of the curriculum areas.

## Conclusion

The InSiTE project has provided an opportunity to make explicit, develop, and share more widely some of the subject-specific PCK teachers need to interact with students in ways that support and enhance student understanding of diverse groups of students. The role of the visual, action, and artefacts in classroom interaction has tended to be overlooked and underplayed. Classroom studies in science and technology education are only just beginning to explore the teacher and student use of multiple and multimodal resources for meaning making and communication. The InSiTE teachers and students used talk in conjunction with written text, visual materials, gesture, modelling and demonstrative actions, and the manipulation and production of objects and artefacts to express and develop science and technology ideas and practices. Teacher and student talk played a pivotal role in interaction, but their talk was invariably anchored and augmented by other modes. When multiple multimodal opportunities are provided the chance of all students being able to contribute is enhanced. Classroom social routines and norms along with the ways teachers design tasks and deploy artefacts distribute authority and support student autonomy and agency. Teachers worked to develop and sustain a sense of continuity and connection across ideas, tasks, and lessons using talk, artefacts, and taken-as-shared routines. Developing ideas and practices were evident in their changing ideas and practices, and their linking ideas across and within tasks, lessons, curriculum areas, and into their everyday lives. This research has provided evidence of ways to enhance teacher PCK and classroom interactions with a flow-on effect on student learning.

## Recommendations and implications

This research project highlights the usefulness of teachers using subject-specific multilayered planning tools to enhance their PCK. This lead to enhanced classroom AfL practices.

The focus of research and professional development has tended to be on teacher talk, but we would recommend a concurrent focus on material resources as a means to support meaning making. Classroom research that explores both the context and nuances of interaction in the moment, and over time, is needed.

## References

Atkin, M. & Black, P. (2003). *Inside science education reforms: A history of curricular change.* New York: Teachers College Press.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education, 5*(1), 7–74.

McGee, C., Jones, A., Cowie, B., Hill, M., Miller, T., Harlow, A., and McKenzie, K. (2003). *Curriculum stocktake: National school sampling study. Teachers' experiences in curriculum implementation: English, languages, science and social studies*. Hamilton: Waikato Institute for Research in Learning & Curriculum, Centre for Science & Technology Education Research and Māori Education Research Institute.

Shulman, L. (1987). Knowledge and teaching: *Foundations of the new reform. Harvard Educational Review, 57*(1), 1–22.

Wertsch, J. (1998). *Mind as action*. New York: Oxford University Press.

*The full reports of all TLRI projects are published on the TLRI website (www.tlri.org.nz).*

## Lead authors and researchers

**Associate Professor Bronwen Cowie,** is the director of the Wilf Malcolm Institute for Educational Research, School of Education, the University of Waikato. Her research interests include assessment for learning, classroom interaction and the role of ICT in teaching and learning.

**Dr Judy Moreland** is a senior research fellow at the Wilf Malcolm Institute for Educational Research, the University of Waikato. She has a special interest in technology education in primary classrooms, assessment for learning, and classroom interaction.

**Professor Alister Jones** is Dean of the School of Education, the University of Waikato. Alister's research interests lie in science and technology education and assessment.

**Dr Kathrin Otrel Cass** is a lecturer at the Centre for Science and Technology Education Research, the University of Waikato. Her research interests include science education, informal education, classroom interaction, and teacher use of ICT resources.

**Participant Partners**

Erin, Julie, Glenis, Bronwyn, Julie, Mary, Louise, Greg, Candy, Tanya, Deidre, Graeme, Paula, Christine, Marianne, and Barbara.