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ENGAGING PARENTS IN STEM: COTEACHING AND COGENERATIVE DIALOGUING IN A QUEENSLAND HIGH SCHOOL

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ABSTRACT

Diminished student interest in science, technology, engineering and mathematics (STEM) is recognised by educators, researchers and public policy makers as a concerning global trend. Inviting stakeholders like scientists and industry specialists to discuss their work is one means schools use to facilitate student engagement in the sciences. However, these visits generally comprise one-off sessions with minimal relevance to students' particular and ongoing learning needs. This case study investigated *coteaching* and *cogenerative dialoguing* with parents in teaching a Year-8 multidisciplinary unit with science and technology foci. Two parents cotaught alongside the resident teacher and researcher over eight months. This paper concentrates on one parent, a medical scientist by profession. Data sources included video and audio recordings of cogenerative dialogues and classroom interactions, student work samples and journal entries. Data were interrogated using the sociological constructs of *fields* and *capitals* and the dialectic of *structure*|*agency*. The findings reveal how (a) the parent's science and technology knowledge was tailored to the students' needs initially and continually and (b) student-generated data indicated enhanced engagement in science and technology. The research speaks to schools and governments about enhancing STEM education by furthering collaborative relationships with relevant stakeholders.

INTRODUCTION

Ways to promote sustained student interest and engagement in science, technology, engineering and mathematics (STEM) occupy educators, researchers and public policy makers in Australia and overseas. Speaking about science education, Tytler (2007) ascribed this preoccupation to dwindling student numbers in science courses beyond the formal school years. He described the situation as critical because science and technology professionals are needed to propel Australia into an increasingly technological age. This is matched by the need to maintain a science savvy citizenry disposed to science (Tytler, 2007). Schools endeavour to address STEM objectives variously. However, lack of preparation and resourcing negatively impact the confidence of many primary and lower high school teachers to teach STEM, especially science (Goodrum & Rennie, 2007). To compensate, they arrange student excursions to permanent facilities like Brisbane's Sciencentre or invite "experts" like the Surfing Scientist to demonstrate science "tricks" or provide interactive hands-on experiences for a day. While such ventures represent genuine attempts to heighten student interest and involve the community in teaching STEM in schools, one-off experiences offer limited opportunities for students to engage in the different knowledge domains. These experiences further risk the "novelty" factor overwhelming learning (Kubota & Olstad, 1991). This is concerning since school science in particular is criticised for failing to connect students' learning and the real world (Aikenhead, 2006). Despite significant changes in curricula and a range of initiatives promoting community links in the last decade, this perceived lack of relevance by students, especially in high school, between school science and reality, persists (Goodrum & Rennie, 2007). This paper shines a spotlight on one part of the solution by

examining how a high school teacher and doctoral candidate used coteaching and cogenerative dialoguing to engage parents in teaching a multidisciplinary unit with science and technology foci. It subsequently explores the benefits for students, teachers and parents as well as potential partners from business and industry.

BACKGROUND OF STUDY

Parents as resources for teaching science and technology

Parents are recognised as valuable resources for teaching children about science and technology. While referring to young children, Fleer's (1996) research highlighted that opportunities to answer science questions typically emerged in everyday contexts as they interacted freely with their parents. In investigating technology teaching in a Queensland primary school, Davis (2005) noted that there were "recurring references in the students' responses to the input of their parents (particularly fathers) and siblings to their technological creations" (p. 120). He elaborated that these responses reflected "the reliance that the students placed on their home context in solving issues they were facing in the completion of their tasks" (p. 120). Davis conjectured that "there may be an underutilised community resource in the form of parents and community members that may need to be further explored by teachers of technology" (p. 121). In other research into Queensland technology education, Knopke (2002) reported that when students worked with outside experts including parents they "benefited from the intensity of the activity and multiple inputs rather than the teacher" (p. 188). Despite these specific findings and general consensus among researchers and educators about the importance of involving parents in students' learning (e.g., Henderson, Mapp, Johnson, & Davies, 2007), most schools continue to invite *traditional* participation from parents. "Traditional" roles include: working in the tuckshop; organising fetes; fund raising; and, attending social and sporting events, open days and parent-teacher interviews (Limerick, 1988). In this study, parents engaged in non-traditional roles as curriculum collaborators and decision-makers of science and technology through the use of coteaching and cogenerative dialoguing.

Coteaching and cogenerative dialoguing

In the last decade, *coteaching* and *cogenerative dialoguing* emerged as a promising mechanism for teaching science (Roth & Tobin, 2002). Tobin (2006) described "coteaching" as when two or more individuals teach a group of students collaboratively across all aspects of teaching including planning, enacting, reflecting and assessing. It differs from other joint teaching practices in its philosophy, theoretical underpinnings and goals (Gallo-Fox, 2009). The purpose of coteaching is for individuals to learn how to teach or to improve their existing teaching while providing students with more learning opportunities than they could singly (Roth & Tobin, 2002). It is theorised that coteaching enhances students' academic and social learning because more than one teacher is operating in the classroom simultaneously (Roth & Tobin, 2002).

"Cogenerative dialogues" or *cogens* go hand-in-hand with coteaching. "Cogens" (noun) describe those sessions that generally follow cotaught episodes when participants discuss the teaching and learning process in which they engaged (Roth & Tobin, 2002). "Cogen" (verb; short for cogenerative dialoguing) is when participants talk, listen and learn from one another despite boundaries of age, gender, ethnicity and social class (LaVan, 2004). Research has highlighted the supportive culture of partnership that frequently develops among coteachers (e.g., Gallo-Fox, 2009; Roth & Tobin, 2002). Studies indicate cogens facilitate this culture (e.g., LaVan & Beers, 2005). One possible reason is the way they operate. Participants are asked to show mutual respect and complementarity through such means as active listening, suspending judgement, according each other equal talk time and reaching consensus on an issue before moving onto another (Tobin & Roth, 2006). Coteaching and cogen are suitable for pre-service teachers learning to teach as well as experienced teachers seeking professional development (Roth & Tobin, 2002). This research included parent participants.

DESCRIPTION OF STUDY

The investigation spanned eight months. It was conducted in a single Year-8 classroom (age = approximately 13 years) in a large co-educational state high school in Queensland, Australia. The participants were:

- John (names are pseudonyms), an experienced English and Studies of Society and Environment (SoSE) teacher. While John cotaught with me for six weeks the preceding year, he held no classroom experience in working with parents.

- Dale and Ruth, parents of two students. Dale and Ruth previously had volunteered to work in classrooms as well as at the school level at their children's respective primary schools. Professionally, Dale was a senior scientist while Ruth co-directed a plumbing company.

- Linda Willis, the author, a qualified teacher and Queensland University of Technology doctoral research candidate.

- A class of 27 students, assembled by the school based on each student's mathematics and science achievement at his/her respective primary school.

This paper draws on data generated from the first cotaught unit, *War and Refugees*. While the unit represented designated learning for Year-8 SoSE students, John had flexibility over developing the curriculum and assessment items. He and the coteachers adopted an inquiry-based approach (see Figure 1). The 13-week unit was delivered in three 70 minute blocks per week with the parent-coteachers joining the classroom for the final session. All participants met to cogen afterward for up to 90 minutes. Between times, we communicated virtually using e-mail (see Willis & Ritchie, 2010). This kept Dale and Ruth informed about classroom happenings while facilitating their participation as coteachers despite being absent physically.

WEEKS 1-6	WEEKS 7-12	WEEK 13
Student immersion in topic through: • outside experts as classroom visitors (e.g., Federal Member of Parliament, teenage refugee, refugee advocate); • Dale's lesson; and • class excursion to simulated refugee camp.	Collaborative small group work involving: • planning, researching and designing assessment tasks to meet negotiated requirements; • exploring design platforms and construction materials; • explicit teaching around design features; and • problem-solving to overcome design challenges.	Presenting students' work at: • parent showcase evening attended by all students' parents and school representatives.

Figure 1. Timeline details of inquiry approach for *War and Refugees* unit.

METHOD

Qualitative case study research using an interpretive approach (Bassey, 1999) underpinned this inquiry. I performed a dual role firstly, as researcher in collecting and analysing the data and secondly, as coteacher in working alongside the participants in the classroom and cogens. Data were collected from various sources. Primary sources comprised video and audio recordings of cogens and classroom interactions. Secondary sources included: e-mail correspondence; student work samples and journal entries; and, semi-structured interviews of John and the parent participants. Data from cogens, lessons

and interviews were transcribed subsequently. I adopted a transcription notation system based on Roth (2005) (see Appendix 1). Data analysis was undertaken using discourse and conversation analysis techniques (Roth, 2005). By analysing what participants said and did, their particular views and experiences of coteaching and cogen became salient. Of specific interest were the coteachers' interactions with one another and the students, and how these changed over time. I acknowledge that my interpretation of what happened in the study is one version of events. To ensure my version is rigorous and defensible I applied numerous checks and balances including thick description (Stake, 2010) and regular member checking (Guba & Lincoln, 1989).

FINDINGS

Engaging Dale through cogen

The paper now focuses on one parent, Dale and her participation in the *War and Refugees* unit. The first cogen enabled Dale to consider her future participation. She indicated that she spent her days staring down a microscope so could contribute nothing to coteaching about the topic. However, as John and I discussed the possibility of one of the students' final group tasks comprising a PowerPoint presentation on diseases experienced by refugees, Dale realised she could provide a laboratory perspective. As Excerpt One below shows, Dale cautiously began:

Excerpt one (cogen 1: episode 14)

01 Dale: I could give them a lab perspective ((Tapping pen four times)) on diseases I'd have to think how I could do it. But yeah, because we have slides, we have= ((All coteachers aligning to Dale))

02 John: =We have laboratories here and we could organise to [swap]

03 Dale: [Microscopes?]

04 John: Yeah, we could organise some and have a laboratory for a lesson or two.

05 Dale: Yeah, I mean I could. Give me time to think about it. I'm sure I could=

06 Ruth: =Two weeks. ((Collective laughing))

07 John: No, no, no=

08 Dale: =No, no, I could come up with something to talk about but I mean in terms of getting resources like I could probably speak to work and get some slides to show the children and stuff like that. Like it wouldn't be contagious or anything like that. ((To John))

09 Ruth: So, no hands on things?

10 Dale: No, nothing. No germs; no <u>real</u> germs. ((Collective laughing))

11 Linda: No real germs. ((Laughing))

12 John: [Plenty enough around here anyway.] ((Laughing))

13 Ruth: [Yeah, see that's where we could go to the science lab.]

14 John: You see we've got four weeks before we get into this. ((Indicating to a teaching calendar)) So we've got two weeks of holidays, four weeks of mapping. So we've got eight weeks before=

15 Dale: =Oh, we can think about/even if it's not to do with the microscope. Even if

I was to have pictures of what's down the microscope. That might be even better in terms of timeframes but I could certainly do something that would be of interest [to the]

16 John: [They have] class sets of microscopes that are designed to be taken to classrooms so if you were to bring in slides of actual malaria parasites.

17 Ruth: Yeah, that'd be cool. That'd be a lot more exciting than a picture.

18 Dale: Yeah, but malaria's rare. ((To Ruth)) But let me think about it.

19 John: Yep.

20 Dale: I'd have to work out how I could arrange it but that could be something.

21 Linda: And we'll certainly facilitate.

22 Ruth: In your capable hands. ((To Dale))

23 Linda: What did you say? ((To Ruth))

24 Ruth: In her capable hands. ((Collective laughing))

25 Dale: [I just have to] think about it.

26 Linda: [Absolutely.]

(27 June, 2008)

As mentioned earlier, Dale worked as a senior scientist. She held tertiary qualifications in Applied Science, Medical Laboratory Science and Clinical Laboratory Techniques. Cogen allowed her to negotiate ideas for coteaching about diseases. These became available for the group's consideration and decision-making. Dale's suggestions included obtaining physical resources from her work such as slides (turn 1) and pictures (turn 15). Her resources for coteaching expanded with John raising the possibility of relocating to a laboratory to mediate classroom constraints of space and equipment (turns 2 and 4) and the school's class sets of microscopes (turn 16). He pointed out time as a further resource (turn 14). Eight weeks were available for planning, not two as suggested by Ruth (turn 6). Dale revealed her views about working with students. These concerned connecting with their interest (turn 15) and safeguarding their health and safety (turns 8 and 10). While Ruth, John and I played supporting roles, our responses evidenced preferred kinds of student experiences. Ruth's comments reinforced John's ideas about going to the science lab (turns 2 and 4) and students viewing slides of actual malaria parasites (turn 16). She added that looking at parasite slides using microscopes would be a "lot more exciting than a picture" (turn 17), an earlier suggestion by Dale (turn 15). Our responses attached notions of importance to students doing rather than learning about science.

Theoretically speaking, cogen helped Dale realise that her *cultural capital* from the *field* of medical science was transferrable to the *War and Refugees* unit. The Bourdieuian (1977) term "field" not only refers metaphorically to a particular physical site but to the *structures* identified with that site. "Structures" comprise *resources* (human and non-human) and social norms, attitudes and beliefs (i.e., *schemas*) (Sewell, 1992). "Cultural capital" describes an individual's knowledge of practices and schemas within a field. The discussion provided Dale with time and space to explore what resources she could bring from her professional field to align with student learning. Her participation was shaped by her knowledge and attitudes from medical science about the suitability of any student learning experiences she could provide. Cogen revealed ways she could convert her cultural capital acquired in science to the field of education. This afforded her *agency* as a parent-coteacher. "Agency" refers to an individual's capacity to act (Giddens, 1984) or, simply put, one's ability to make things happen. Dale's agency was enhanced by

virtue of the structures operating in the field of coteaching and cogen. For example, other people's ideas and suggestions became resources for her decision-making. The process is explained by conceiving of structure and agency dialectically (i.e., structure|agency) (Sewell, 1992). Like dual sides of a coin, the existence of one entity presupposes the other (Roth, 2005). Structures available through cogen enabled Dale to exert her agency as a parent-coteacher according to the capital she brought from the field of science.

The episode highlights how cogen facilitated collaborative relationships among the participants despite the innate role disparities and power differentials that exist between parents and teachers. Dale, not John, was cast as "expert" coteacher throughout the conversation. She explained with authority to Ruth, for example, that "malaria's rare" (turn 18). The coteachers recognised and acknowledged Dale's cultural capital in science by their utterances such as Ruth's reference to Dale's "capable" hands (turns 22 and 24) and my comment of "absolutely" (turn 26). Other evidence included the way each coteacher positioned his/her body to focus on Dale (turn 1) and synchronous laughter signifying collective agreement (turn 24) and individual support (turns 11 and 12). Cogen structures such as active listening and discussing a topic thoroughly before moving onto something new allowed Dale's professional role as a scientist to be validated. This conclusion is further informed by the excitement she manifested about her work. She declared later, "There's some beautiful-looking parasites. I tell you, they can cause some horrific stuff but they look great under the microscope." Her statement generated collective laughter. This and other positive interactions throughout the episode (e.g., turns 10 to 12) make salient how cogen enabled group members to accrue *social capital* with one another. "Social capital", a form of cultural capital, emphasises "who" over "what" an individual knows. A person accrues social capital by virtue of possessing durable networks of relationships of mutual acquaintance and recognition (Bourdieu, 1992). Cogen created an equitable supportive environment that allowed individuals to accumulate social capital with one another. This explains how traditional parent-teacher roles between John and Dale operated differently in the episode.

Dale's lesson

After engaging in coteaching and cogen for five weeks, Dale's agency as a parent-coteacher grew considerably. This is evidenced in the science lesson on diseases that she led in week six:

Excerpt two (lesson 5)

01 Dale: Good morning 8-11.

02 Class: Good morning teachers.

03 Dale: I don't know if you know, but by profession I'm a medical laboratory scientist. So, I would like to invite you to take a walk in <u>my</u> shoes. ((Pointing to the words on the whiteboard)) And we'll have a look from the laboratory point of view in regards to diseases that refugees suffer. ((Donning a laboratory coat))

(15 August, 2008)

The opening interaction highlights the changed structures operating in the cotaught classroom. Dale, for example, exercised her agency gained over the preceding weeks by saying, "Good morning" on behalf of all the coteachers. The students' collective response indicated acceptance and recognition of her role as parent-coteacher. Dale's introduction positioned the students so that connections between her work as a scientist and the topic of refugees were visible. Tactics that emerged through cogen such as harnessing the metaphor of walking in my shoes and wearing her lab coat reinforced these links. Student booklets prepared by the coteachers under Dale's guidance and arranged on benches enabled her to move without pause onto explicating the medical laboratory rules. Aspects covered included: appropriate clothing (e.g., closed-in footwear); eye protection (Dale supplied each student with safety goggles); and, universal precautions (e.g., wearing disposable gloves and washing hands to avoid contamination). Dale replicated structures from her field of medical science in the classroom. In doing so, she exerted her agency as a parent beyond that of her previous participation in schools.

Dale highlighted the fit between her knowledge of science and the students' learning needs. She made connections on three levels: the curriculum, students' interest and the real world. These links had become salient through cogen. Firstly, on the curriculum level, her statement, "And we'll have a look from the laboratory point of view in regards to diseases that refugees suffer" (Excerpt Two) harked back to a conversation in cogen 4. Dale was concerned about how science was relevant to the SoSE curriculum. John and I subsequently discussed how teaching science in SoSE represented an integrated curriculum approach which we mutually embraced. John explained how a science background about diseases would enable the students to understand the situation facing refugees better (see Willis & Ritchie, 2010). Dale's introductory statement made these curriculum connections explicit for the students.

Secondly, Dale tapped into the students' interest in science. John highlighted the significance of Dale's lesson for these particular students in cogen 4.

Excerpt three (cogen 4: episode 3)

01 John: I'm sure that there are children in that class who will end up in biology somewhere when they get older. ((Dale nodding))

02 Dale: Well [see, I love my job.]

03 John: [And this could] really influence them to really consider it as a career.

04 Dale: Well but this is/well I would love that.

05 John: Because they've all got an interest in science.

(1 August, 2008)

Dale appealed to the students' interest in science variously. She organised a range of hands-on activities including plate streaking and creating a wet prep which the students performed aided by the coteachers. Simultaneously, students were immersed in the metalanguage of science associated with diseases and laboratory equipment and techniques. She incorporated information that caught her attention when undertaking online research. For example, when speaking about tuberculosis she observed, "And this is another interesting statistic. Someone in the world is newly infected with TB bacilli every second and one third of the world's population is currently infected with TB. So that's quite amazing isn't it?" She also revealed *insider-knowledge* from her field by comments like, "they call the faeces 'rice water'" and "it's what they call the 'benign' malaria." "Insider-knowledge" was a kind of specific information of high interest to students because apart from Dale's contemporary working knowledge of medical science it was otherwise inaccessible to them.

Thirdly, Dale connected the students' learning with their everyday world. She mirrored comments made in cogen linking diseases experienced by refugees with our shared humanity. For example, she stated:

> We can all get them. It's not just because they're refugees. If we were living in the same environment under the same conditions that they do we ourselves can get it as well so it's not just because they're refugees. It's because of where they live and their environment and the climate that they live in.

Using personal language (e.g., "we ourselves can get it as well"), Dale humanised the learning experience and sharpened real world connections for the students. Compared with her tentative offer to provide students with a laboratory perspective in cogen 1, she spoke and acted purposefully throughout her lesson. She was agential knowing that what she presented by way of curriculum, students' interest and the real world matched the coteachers' goals for student learning as revealed and confirmed in cogen.

Dale's lesson resulted from discussion, decision-making and planning among the coteachers over several weeks. It centred on three diseases commonly experienced by refugees: cholera, malaria and tuberculosis. Differences in these three (e.g., transmission, symptoms, treatment, preventative measures and indications) emerged

during cogen and subsequently provided Dale with a pedagogical platform for classroom enactment (see Willis & Ritchie, 2010). She introduced students to each disease using clinical notes devised for hypothetical patients. As a result of cogen, I prepared overhead transparencies of pictures of organisms under the microscope from her medical science textbooks. She incorporated physical resources accessed through the school and her work. During cogen, for example, John invited the coteachers to visit the science department. Here we discussed our needs with the Head of Science, reconitrated the laboratory space and equipment and discovered the school had a television microscope. In discussing her project at work, Dale obtained other resources including an army medics' kit for testing malaria without a microscope. She concluded by providing students with one-page summaries on each disease to support their future work. Dale exerted her agency in the lesson in line with her participation in the field of coteaching and cogen. Structures in the field allowed the coteaching collective to access her resources while simultaneously affording her access to the resources of the collective (Willis & Ritchie, 2010).

Student learning

Dale's lesson

Dale's presence as a parent-coteacher with specialist knowledge in science provided John and the class with an immediate and ongoing resource for classroom teaching and learning. An interaction from her lesson is illustrative:

Excerpt four (lesson 5)

01 Dale: As I said there are four different types of malaria and they have different intracellular/can someone tell me what intracellular means? ((Linda scribing on whiteboard)) Yes, Greg. ((Student))

02 Greg: Inside a cell.

03 Dale: Inside a cell. Well done. So you can imagine/if I tell you that a red blood cell is seven microns big, you can imagine how <u>tiny</u> these guys are. ((Dale circling projected image on whiteboard))

04 John: How big's a micron? Does anyone know how big a micron is?

05 Mark: [Really small.]

06 Len: [We've done this in science.]

07 Brad: Isn't it a thousandth of a millimetre?

08 Dale: It's a tenth to the sixth. ((To John))

09 Linda: Ah, yeah. ((Linda writing fraction on whiteboard))

10 Dale: I think it is, yeah. ((To Linda))

11 John: Ten to the sixth? So, that should be one millionth of=

12 Dale: =Yeah, <u>one millionth</u>= ((To John))

13 John: =of a?=

14 Linda: =Metre=

15 Dale: =Metre. Metre? Does that make sense? No. One millionth of a-

16 Kurt: Centimetre. ((Student calling out))

17 John: Well if it's a millionth of a metre then it would be a thousandth/one thousandth= ((To class))

18 Dale: =Yes=

19 John: =of a millimetre.

20 Dale: One thousandth of a millimetre. ((Linda representing information mathematically on whiteboard))

21 John: So, there you go. One thousandth of a millimetre. ((To class))

John frequently sought clarification and verification from Dale on aspects of science during lessons and cogens. This episode is representative of others when the coteachers thought out loud to solve a problem collectively. Structures available through coteaching made this possible. Dale, for example, had built social capital with the students, referring to them by name (turn 1). As she circled the image of the cells, John used the momentary space to question them further (turn 4). After several student responses, Dale claimed authority by speaking directly to John and introducing a new way to frame the information (i.e., using exponential terminology) (turn 8). I subsequently represented the information visually for students by writing the fraction on the whiteboard. Dale's hesitation led to John's additional questions by way of clarification for himself and the students (turns 11 and 13). In completing each other's sentences and uttering parallel responses (turns 11 to15), a solution was jointly reached (turns 17 to 21). Developing ease and comfort with our coteacher roles were evidenced throughout the episode. This made salient our cultural and social capital built previously during coteaching and cogen. Dale's role as a coteacher meant she embodied a resource for teaching and learning about science that John, coteachers and the students tapped whenever she was present.

Student technology tasks

The information presented by Dale in her lesson particularly, and throughout the unit generally, infused the assessment tasks the students produced (see Figure 1). Relevant to this paper are their technology tasks in which they re-presented their learning using various modes and mediums. Students were asked to consider themselves as non-government aid organisation (NGO) employees and devise products suitable for volunteers in refugee camps overseas. Based on the aims of Queensland's technology curriculum, students' products needed to match specific contexts, purposes and audiences. The students' work included considerable information derived from their science learning. One group manufactured an Education Pack containing brochures on: endemic diseases and respective symptoms, preventions and cures; general hygiene advice; and, first aid. A second group organised an Advertising Campaign featuring brochures, posters and a radio commercial. The campaign was designed to recruit aid workers to provide medical care and education on disease prevention. Of significance was the information students included in these tasks not presented by Dale in her lesson. Shared coteaching experiences such a visit to a simulated refugee camp exposed gaps for Dale in her own knowledge about diseases and refugees. She subsequently emphasised these during coteaching and cogen. Examples included the impact of measles on refugees and the importance of immunisation programs. As a coteacher, Dale learnt alongside the students. In refining her knowledge and understanding she became an ongoing resource for coteaching science.

Students' changed schemas

Before the study ended, students evaluated their respective experiences of coteaching with parents using a questionnaire the coteachers prepared. Comments about the benefits were overwhelmingly positive. One wrote:

> I would say that coteaching is a good experience where the parents of students are in the classroom with them, but helping other students as well as their child. It helps you learn more knowing that more learning resources are available.

Students identified specific benefits such as, “Being taught the missing links that other teachers do not know.” Over half commented on Dale’s contribution. For example, “[Dale] brought her biotechnology resources and showed us how to use them and we got to use the resources.” Over 70 percent described positive changes in their attitudes and beliefs about refugees. One remarked, “Surprisingly it has changed dramatically about what I think of refugees. By learning of the things the refugees have to go through it really showed me how lucky we are.” The students’ changed schemas carried through to their behaviours. At a showcase evening of the unit’s work to the students’ parents, several students spontaneously collected money for an NGO. The following term, the school participated in the CARE Australia program to raise money for poor communities overseas. The class collected a significant amount compared with other classes and compared with John’s previous classes. During cogen he, Dale and Ruth attributed the students’ response to learning about refugees. Structures available through coteaching appeared to strengthen students’ real world connections as demonstrated by their actions.

DISCUSSION AND CONCLUSION

This paper focused on how coteaching and cogen with parents facilitated science and technology education. The paper concludes by discussing the intervention’s benefits for students, teachers and parents as well as potential partners from business and industry.

Student learning is discussed using the nine themes for describing the ideal science education (Goodrum, Hackling, & Rennie, 2001). This study satisfied several themes. Dale’s participation enabled the students to access her science resources in meaningful ways over a sustained period. The curriculum carried personal value for all students and enhanced their individual agency as demonstrated by their words and behaviours during and after the unit. Dale’s presence as a parent-coteacher and the currency of her microbiology knowledge and skills constantly reminded the students that their learning was relevant to the everyday world. Declining enrolments in science courses is linked to students’ limited understanding of the range of science-related careers and their importance (Goodrum & Rennie, 2007). Dale showed the students what scientists do and what being one was like. Through coteaching and cogen we accessed her considerable cultural capital in microbiology. This included her dedication to life-long learning and the enjoyment and fulfilment she derived from her work. Using coteaching in the context of an inquiry-based approach to curriculum planning, delivery and assessment further benefited students. Designing and producing their technology tasks involved them in active inquiry, research and innovative use of ICTs as well as working in teams and individually. There were clear links among these tasks and the students’ experiential learning throughout the unit, especially in science, and their assessment. Finally, coteaching with parents created a supportive classroom environment. The structures of the cotaught classroom afforded an array of teaching strategies and opportunities to interact with students in providing information, feedback and encouragement than were possible for John alone.

This research has significance for teachers as seen by John’s role and the benefits he accrued. John indicated that working with parent-coteachers validated his role as teacher (see Willis, 2009). This paper highlighted how Dale’s participation enabled him to access her cultural capital in science continually throughout the unit. This carries important ramifications for teachers wishing to keep abreast of the latest science discoveries and cutting-edge technologies so they can offer a relevant and worthwhile curriculum. Dale’s participation enabled John to engage in professional learning in-situ thus mediating the impact of lost classroom time, inconvenience and travel associated with usual forms of professional development. Cogen afforded John time and space to reflect on his teaching and student learning in a collaborative and mutually supportive environment. Time for regular reflection and renewal is identified as key to teachers’ professional development in science (Goodrum & Rennie, 2007). This paper contrasts John’s role as a coteacher to that played in the classroom usually. Throughout the unit he brought his considerable cultural capital in the field of education to bear. This encompassed his knowledge of curriculum content as well as his valuing of an integrated inquiry-based curriculum approach. He understood the students’ needs and ways to engage them. He also understood the structures operating at the school level. In

coteaching with parents his role was crucial in balancing these factors. In doing so, he set an example of what is possible for other teachers willing to reconceptualise their teaching.

Significance for parents concerns the way this study challenged traditional approaches to parent-school engagement. The study makes an important statement given government rhetoric across Australia and overseas calling schools to involve parents more meaningfully. These calls respond to extensive research evidence positively linking parent engagement in students' learning and academic performance with school success (e.g., Henderson et. al., 2007). As previously indicated, rarely do parents engage in schools as curriculum partners and decision-makers let alone in the context of STEM education. Most studies on parents in classrooms focus on deficit accounts in which they operate with a few students in withdrawal situations. Not only did coteaching and cogen allow us initially to access Dale's particular skills in microbiology along with the network of individuals and resources surrounding her, she became an ongoing resource for teaching and learning for the whole class including the coteachers. Dale also exercised considerable agency over how she participated. Opportunities for consultation and negotiation afforded through cogen allowed her to invest capital from the fields of science and parenting in the classroom that aligned with ways she preferred. Dale indicated that as a parent-coteacher she experienced a heightened sense of self-efficacy and enjoyment compared with any previous school involvement (see Willis, 2009). Her specific role gave her first-hand insight into the field of education. In particular, she commented about how most of what teachers do is invisible to students and their parents. As a parent-coteacher, her respect and understanding about the role of teachers and their work were enhanced.

A further dimension of this paper is in highlighting the significance for potential partners from business and industry. One important benefit of coteaching and cogen is in identifying ways capital can be transferred among fields to meet educational needs in schools. Dale's failure to recognise initially how her capital from science could be used in the unit makes this salient. Her participation throughout the study highlights how cogen facilitated clear channels of communication that maximised our use of time individually and collectively. As opposed to "hit and miss" approaches, the process allowed us to match the resources needed at school with what she could supply. This study is timely given Australia's projected skills-shortage in STEM-related industries (Tytler, 2007) and the Federal government's call for ways to forge school-business partnerships (Business-School Connections Roundtable, 2010). Coteaching and cogen offers a practical strategy to form and maintain partnerships with enhanced educational outcomes for all stakeholders.

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APPENDIX 1

A: [I'm] looking at B: [Oh]	Brackets indicate overlapping speech.
A: curves= B: =Oh	Equal signs are used to signify no audible gap between one utterance and the next.
A: <u>Fas</u>ter	Underline indicates stress in delivery.
A: Envi-	A dash marks a sudden stop in the utterance.
A: /	A forward slash signals self-correction by a speaker.
((Circles))	Double parentheses enclose transcriber comments.

(Roth, 2005, p. 460)