



Using cogenerative dialogue to address heightened emotions with difficult students

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Abstract

In “It’s the magic circle”! cogenerative dialogue is used to create a safe environment to address emotional conflicts in a project-based learning (PBL) science internship. Hsu is drawing on polyvagal theory (PVT) and event-oriented enquiry to show how educators can use cogens as a pedagogical tool to successfully address emotional conflicts between scientists and high school students in a PBL science internship through respectful communication emphasising equality. Cogenerative dialogues (cogens) have been used as a methodological and pedagogical tool for a number of years. Cogens can transform teaching and learning environments, produce positive emotional energy, increase participation of stakeholders and give voice to participants. The event “the Lucy incident” that is central to Hsu’s study occurred when a cogen was conducted that did not adhere to the rules of cogen and the dominant voice of the scientist became central. “The Lucy incident” was a significant event that transformed the interactions amongst all participants afterwards. After reading Hsu’s paper, we were intrigued by some similarities between her study and our research. In a previous study by Jennifer Oakley (Understanding emotional climate: interaction rituals and cogenerative dialogue in a beginning science teacher’s classroom, Queensland University of Technology, 2016) of cogen in a beginning science teacher’s classroom, a similar exertion of power by a classroom teacher resulted in a failed cogen. Thus, in this forum paper, we aim to address those similarities and discuss the differences through the lenses of PVT and interaction ritual theory.

Keywords Cogenerative dialogue · Polyvagal theory · Interaction ritual theory · Science teaching

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This review addresses issues raised in Pei-Ling Hsu’s paper entitled: “It’s the magic circle”! using cogenerative dialogues to create a safe environment to address emotional conflicts in a project-based learning science internship. <https://doi.org/10.1007/s11422-018-9906-9>.

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Resumen

En el Proyecto denominado “El círculo mágico”! se usaron diálogos cogenerativos (cogen) para crear un ambiente seguro que permitiera abordar los conflictos emocionales durante estancia de aprendizaje de las ciencias basado en proyectos. Hsu se basa esta investigación en la teoría polivagal (PVT) y orienta la investigación a eventos para mostrar cómo los educadores pueden usar diálogos cogenerativos (cogens) como una herramienta pedagógica para abordar con éxito los conflictos emocionales entre científicos y estudiantes de secundaria durante una estancia de aprendizaje de las ciencias basada en proyectos de PBL a través de comunicación respetuosa enfatizando en la igualdad. Los cogens se han utilizado como instrumento metodológico y pedagógico durante varios años. Los cogens pueden transformar los entornos de enseñanza y aprendizaje, producir energía emocional positiva, aumentar la participación de los interesados y dar voz a los participantes. El evento “el incidente de Lucy”, que es central para el estudio de Hsu, ocurrió cuando se llevó a cabo un cogen y no se adhirió a las reglas en consecuencia la voz dominante del científico se convirtió en central. “El incidente de Lucy” fue un evento significativo que transformó las interacciones entre todos los participantes. Después de leer el trabajo de Hsu nos intrigaron por algunas similitudes entre su estudio y nuestra investigación. En un estudio previo de Jennifer Oakley (2016) de cogens de un nuevo profesor de Ciencias, un ejercicio similar de poder por parte de un profesor de aula resultó en un fallo de cogen. Por lo tanto, en este foro, nuestro objetivo es abordar esas similitudes y discutir las diferencias a través de las lentes de PVT y la teoría ritual de interacción.

Background to Hsu’s study

Pei-Ling Hsu’s paper provides interesting outcomes for the use of cogenerative dialogue (cogen) in science education. In Hsu’s study, cogens were used to discuss and address issues about the progress of a project-based learning (PBL) science internship undertaken by nine secondary school students and scientists working at a university (Hsu 2019).

The rules of cogen were clearly explained to all participants (students and scientists) prior to cogen being implemented. These rules are each person 1. has equal turns and times to talk; 2. shows respect and listens attentively to others; 3. plans to address issues that are generated and implemented in further practice; and 4. makes available for discussion video clips of collective practice.

The event, “the Lucy incident”, that is central to Hsu’s study occurred when a cogen was conducted that did not adhere to the rules of cogen. During this cogen, a student raised a criticism that had been made by an alumnus of the internship program. This criticism was about the students’ progress, insinuating that the scientists’ supervision of the students during the project was not adequate. In response to this criticism, one scientist, Ms. Karen, expressed negative emotions stating, “I hate to say it, I’m a little insulted” followed by a justification of the work being undertaken in the internship program. The indignation expressed by the scientist was “consistent with traditional power structures in which student voices needed to comply with extant power structures” (Hsu 2019). On this occasion, the rules of cogen were no longer a priority and the dominant voice of the scientist became central.

The lead scientist, Dr. Mac, had been informed of the discussion that took place in the cogen, and in response, reported the event to the program director stating that the alumnus who had initially proffered the criticism was no longer welcome in his laboratory. An emergency cogen was held the following day, called and facilitated by Dr. Mac. Hsu reports that again, the rules of cogen were breached, with Dr. Mac and Ms. Karen exercising their positions of power to dominate the discussion and chastise the students regarding their performance in the internship. It was clear that Mr. Mac and Ms. Karen's response may have resulted in students exercising caution when raising issues for discussion in cogen. However, further cogens elicited a shared understanding of the issues regarding student performance, and cogenerated action plans regarding students' time management and scientists' roles as leaders in the learning process were developed and implemented. During these successful cogens, power imbalances were not evident and the rules of cogen were followed, providing the impetus for resolution of the issues discussed and arising from the initial event.

Cogen is characterised by the removal, as much as possible, of the power differential between students and the adults (mentors, teachers, scientists) who are in positions of power that are institutionally reinforced by the power structures common in schools and universities. However, as evidenced in Hsu's study, cogens often fail due to the breach of cogen rules by participating adults in positions of power.

A failed cogen: Ashley "broke the rule"

In a previous study of cogen in a beginning science teacher's classroom in the middle years (see Oakley 2016), a similar exertion of power by the classroom teacher resulted in a failed cogen. The classroom teacher, Ashley, exerted power in two differing ways, one prior to cogen and the other during cogen. Ashley, the beginning teacher in Oakley's (2016) study, had organised and facilitated three successful cogens, in which students volunteered to participate, and the explicit rules of cogen were followed. However, following the third successful cogen, Ashley decided that she wanted three particular students to participate in the fourth cogen. The students that Ashley targeted for participation were quiet, hardworking and conducted themselves appropriately in the science classroom setting. An issue that had arisen in the previous cogen had been the disruptive behaviour of particular students in Ashley's classroom, and Ashley wanted to explore how and whether these behaviours were impacting on these three quiet students. While the selection of these three students was well intentioned, not one of the students was a willing participant in the cogen, despite those students having signed ethics forms to participate in the project. Ashley told them that they must attend, hence utilising her power as the classroom teacher and thus creating a power differential prior to the cogen.

It was an awkward cogen, with Ashley asking probing questions that the students seemed unwilling to explore. When Ashley asked the students whether the behaviour of Cody (a disruptive student in the class) was affecting them and their learning, the students did not engage in a turn-taking dialogue with Ashley or each other, and proffered responses that provided little insight into what was being asked, as seen in Excerpt 1.

Excerpt 1 An awkward cogen

Turn	Speaker	Dialogue
01	Ashley	How do you find Cody? Like is he disturbing you, does it affect your learning?
02	Nikki	(pause 4.0 s) U:::m.
03	Ashley	What do you think Jane?
04	Jane	I guess?
05	Ashley	I actually find it really hard to teach sometimes with Cody, well when he calls out all the time...It's well not really fair on everyone else is it?

As Ashley asked the students the initial question, “How do you find Cody? Like is he disturbing you, does it affect your learning?” (turn 01), she leaned back in her chair with her hands entwined on her lap. She did not direct her question at any one student in particular, but during the silent pause following her question, she leaned forward, placing her hands in a prayer-like position under her chin, and pointedly looked at each student in turn. The students were all looking downwards, towards their laps or the floor, making no eye contact with Ashley, until Nikki glanced upwards, catching Ashley’s eye and articulated a fumbling and drawn out “Um” (turn 02). Ashley directed her gaze at Jane and asked Jane what she thought. Jane startled, made eye contact with Ashley and stated, with an upward inflection on the final word, “I guess” (turn 04), before returning her gaze to the floor. Ashley directed her next comment and question to Jane, gazing directly at her with a frown and shaking her head slightly as she asked the question “I actually find it really hard to teach sometimes with Cody, well when he calls out all the time. It’s well not really fair on everyone else is it?” (turn 05). Jane raised her head, gazed directly at Ashley and shook her head slowly in agreement with Ashley. Similarly, Nikki also shook her head but continued to gaze at the floor. The third student remained quite still during this interaction and did not make eye contact with Ashley.

Utilising Randall Collins’ (2004) Interaction Ritual Theory as a lens to understand these interactions, it is clear that the interactions between Ashley and the student participants of cogen were unsuccessful, in that there was no dialogical turn-taking, synchronised body movements or collective emotion. Further, the following interactions throughout this cogen were similar in nature with Ashley asking questions and the students providing uninformative and indecisive replies. While these interactions were unsuccessful, the balance of power lay with the classroom teacher who imposed the direction of the conversation, and through probing questioning, did not encourage dialogue and equal turn-taking. Thus, the rules of cogen specifically that “each person has equal turns and times to talk” were breached through the enactment of the power differential, leading to an unsuccessful cogen. It is interesting to note that Ashley called this cogen to an end after only 8 min, with recognition by Ashley that “I didn’t do that very well did I?”

This instance of the classroom teacher enacting her power before and during cogen, alongside the unsuccessful cogens from Hsu’s study, highlights the difficulty of enacting the rules of cogen, especially when the participants have varying degrees of power due to their roles in the institution and then are required to come together on an equal footing. Hsu’s study provides evidence of how the traditional power structures (i.e. laboratory supervisor versus students on internship) within science education settings can occupy the cogen space despite the rules of cogen being taught as a foundation to the interactions. In these instances, the teachers responsible for mentoring and teaching the students exerted authority and influence, breaching the cogen rules. In the shared space of cogenerative dialogue, power and status (actual and perceived) are

theoretically nullified by the rules of cogen, which exist to reduce the differences in power and status between and amongst students and teachers (Stith and Roth 2010). A breach of the cogen rules by those in positions of power leads to unsuccessful cogens that do not create a shared understanding amongst participants nor allow for the development and implementation of shared action plans.

The practice of cogenerative dialogues

An important aspect of cogen is that participants in cogen are willing participants. This is true of the cogen participants in Hsu's study, as the internship program was part of a research project on the use of cogen, and thus participants in the internship (scientists and students) were aware that participation in cogen was an integral part of the PBL internship. Similar to Hsu's study, the subjects in Oakley's (2016) study received training on cogen and had a clear understanding of the rules of cogen. However, the students in Oakley's (2016) study were not expected to participate in cogen; students were asked to volunteer if they wished to participate. The students in Ashley's fourth cogen were unwilling participants although they had signed ethics forms to participate in the research. Ashley recognised that this was a significant factor contributing to the failure of the cogen. In a debriefing session on the evening of this cogen, Ashley articulated the following:

I thought it was going to work out really well, you know, having those kids in the cogen. I really wanted to hear what they had to say, but I think, you know, making them come was a big mistake. They didn't talk! They really just didn't want to be there. I was trying to like, make sure we heard from different students that would give me more information, but if they don't want to do it you just can't force them. I broke the rules (Ashley, debriefing session)

Ashley acknowledged that while it was important to include a variety of student participants, perhaps differing in areas of gender, culture, classroom behaviour and academic ability (LaVan 2004), it was futile to include unwilling participants in cogen. Further, Ashley's comment "I broke the rules" was in recognition of the rules she displayed in her classroom which aligned with Sarah-Kate LaVan's (2004) guidelines below when she was introducing the concept of cogen to her students.

There are rules for these dialogues everyone has to follow. No voice is privileged. You can speak freely. What you say isn't limited or used against you. No one has more power than anyone else in the group. If you don't wanna participate you don't have to. No one is pressured to do anything. (LaVan 2004, p. 69)

When asked what she would do differently next time, Ashley replied "I'll go back to calling for volunteers. The cogens have worked really well when the kids want to be there". Following this unsuccessful cogen, Ashley held seven more cogens. Each of these had student participants who volunteered to participate, and all were successful in terms of the rules of cogen being upheld. Thus, it appears that for a successful cogen to occur, where shared understanding and action plans are generated, willing participants are essential. Further, the rules of cogen must be followed with no exertion of power or authority preventing participants from having equal turns in the dialogue.

Polyvagal theory as a lens to understand the responses

Hsu's study draws on polyvagal theory (PVT) to describe and understand how the use of cogen as a pedagogical tool successfully addressed conflicts between scientists and students undertaking a PBL internship. This theory provides understandings of human behaviour in social settings; specifically, social engagement, fight or flight and immobilisation. When a social situation is considered safe, the tools of social engagement such as facial expressions, eye contact and vocal intonation are accessible to the individual.

Further, if the environment is perceived as physically and socially safe, fight/flight and immobilisation mechanisms are inhibited. However, if a social situation is not perceived as safe, fight/flight and immobilisation mechanisms are recruited sequentially. It is important to note that the perception of safety or lack of safety of an environment or situation is not always a conscious perception. Neuroception, a term coined by Stephen Porges (2009), is a neural process that enables humans and other mammals to engage in social behaviours by distinguishing safe from dangerous situations.

Students' immobilisation

Hsu provides interesting examples of fight/flight and immobilisation behaviours in cogen. For example, Ms Karen exhibited fight behaviours when she was presented with the criticism made by the internship alumnus. This was evident in the expressions of her negative emotions and monologue of her justifications of the internship program. These fight behaviours were problematic in the cogen as Ms. Karen's voice was dominant over the students' voices.

During the emergency cogen called by Dr. Mac, Vera, one of the internship students, was visibly upset. When Dr. Mac acknowledged that the conversation was emotional for Vera, Vera did not make eye contact with Dr. Mac or the other cogen participants. Thirteen seconds of silence preceded her statement of "Leave me. I don't want to talk". Vera cried and withdrew from the conversation by leaving the room. Hsu presents Vera's reaction as immobilisation behaviours and argues that Vera did not perceive the social situation of cogen as safe, and thus the tools of social engagement were not accessible to her.

Similarly, a classroom interaction between the classroom teacher Ashley and one of her students Brett, in Oakley's (2016) study resulted in behaviours where Brett withdrew from engaging with the teacher and other students. Ashley was presenting a Year 10 science lesson on variations in populations. Brett perceived a joke made by a student and then carried on by Ashley, as an insult.

Excerpt 2 Ashley's joke fell flat

Turn	Speaker	Dialogue
01	Ashley	In a population, there will be some sort of variation. For example, in the population of our classroom, we have a number of variations. We have boys and girls.
02	Simon	And Brett.
03	Ashley	And Brett. We have.
04	Ashley	You're so special Brett you get a category of your own.

While Ashley's last comment in Excerpt 2 (turn 04) was said in an upbeat manner, seemingly designed to elicit a positive transaction in the form of laughter (Oakley 2016, p. 148), the joke "fell flat" (Collins 2004, p. 51). Brett's reaction was one of embarrassment; his face flushed, his shoulders sagged and he directed his gaze at his desk. It appears that the comment of Brett being in a category all of his own recruited Brett's immobilisation mechanisms. Brett slouched at his desk, with his hands on his lap, and did not move or shift his gaze for 47 s after this interaction.

Brett's stillness for 47 s is similar to the 13 s pause before Vera responded to Dr. Mac's comment in Hsu's study. In both of these situations, the students exhibited signs of immobilisation (stillness of body) without fear. This defence strategy was manifesting in a behaviour shutdown and frequently accompanied with physiological change, such as decreased heart rate and slow breathing with drops in blood pressure (Porges 2007).

However, to understand better Brett's and Vera's responses to a threatening situation requires more data. Porges explains that in situations where an individual's neuroception assesses a situation as unsafe, mobilisation behaviours of fight/flight are recruited before the more primitive immobilisation behaviours (e.g. freezing and not being able to move) (Porges 2017). Physiological responses differ between mobilisation and immobilisation behaviours, and thus data would need to be collected of, for example, heart rate and blood flow, particularly to the brain to understand better the physiological responses and how the physiological system responds. In a previous study of Kenneth Tobin, Donna King, Senka Henderson, Alberto Bellocchi and Stephen Ritchie (2016), multilevel analysis of heart rate, blood oxygenation, narrative and prosody is used to determine the teachers' emotional responses when teaching in a university classroom. These data enabled a richer understanding of emotions of the teacher who expressed "high levels of stress and anxiety" when teaching a new cohort of students. This suggests a variety of data sources, other than cogens, are required to understand better emotions and whether physiological responses contribute to changes in behaviour, such as mobilisation and immobilisation. Understanding the nervous system and physiological responses will provide more insights into how PVT applies to situations.

Following Excerpt 2 where Ashley's "flat" joke was made in class, a cogen was held with Brett and other students regarding the comments made by Ashley about Brett. In this cogen, participants viewed a video recording of this event between Ashley and Brett. Brett shared his perception of his interaction with Ashley in Excerpt 3.

Excerpt 3 Cogen: Brett is not happy

Turn	Speaker	Dialogue
01	Brett	I was put in another gender. She put me in another gender like singled me out in front of the whole class. She called me gay.
02	Cody	No she didn't. It was just a joke. She didn't mean it.
03	Brett	I know. I think she was just having a joke, so you know.
04	Researcher	What were you thinking when she said it?
05	Brett	Singled out. Brett's a human! It wasn't funny. She was trying to be funny but it didn't work.
06	Cody	Yeah but she'd never say that.
07	Brett	I know, but like know like at the time.. um... I didn't know that. That's what it seemed like. But yeah, well, I know she didn't say it, I just thought she did.

Excerpt 3 demonstrates that Brett did not respond positively to being singled out. In a secondary classroom setting, singling students out possibly identifies the student as being somewhat different and could be considered a norm violation. Furthermore, Brett's transactional needs do not seem to have been met during this interaction. Jonathan Turner (2007) explains that individuals have expectations in regard to interactions. These expectations refer not only to the outcomes of an interaction but also to the realisation of transactional needs such as the need to be included. The data from the cogen indicated that the transactional need of group inclusion, that is the feeling of being part of the group rather than being singled out, was not met in Brett's interaction with Ashley, arousing negatively valenced emotion in the student. Further, an outcome of successful interactions can be group solidarity (Collins 2004) but this did not eventuate from these interactions.

In the moment of the interaction, Brett was in a "refractory state" (Ekman 2003, p. 39), focussing only on the norm violation, which he believed was Ashley calling him gay. In this state, attention was focussed only on the problem and not on "information that does not fit, maintain, or justify the emotion that we are feeling" (Ekman 2003, p. 39). That is, when Brett reflected on the interaction, he recognised that Ashley did not call him gay, but it appears from his comments in the cogen that in the moment, he was unable to recognise this.

Collins (2004) discusses how individuals respond to norm violations and argues that minor violations will often be responded to with amusement, while more serious violations may be responded to with embarrassment and contempt. It is evident that Ashley's comment about Brett being in a category all of his own was perceived by Brett as a serious norm violation. Viewing this through the lens of polyvagal theory, Brett's behaviour of remaining still with a consistent and unmoving gaze after Ashley's comment in Excerpt 2 (turn 04) indicates that Brett was experiencing immobilisation behaviours. However, immobilisation behaviours occur secondary to mobilisation behaviours of fight or flight. That is, immobilisation behaviours are the last line of defence in an unsafe situation or environment. Thus, without data demonstrating the physiological state of Brett, it is not possible to ascertain whether Brett's mobilisation or immobilisation defences were activated.

Brett's immobilisation and withdrawal

Another interesting interaction occurred between Brett and Ashley, 47 s after Ashley's comment "You're so special Brett you get a category of your own" (Excerpt 3, turn 04). Two students near Brett were talking, and upon hearing the whispered conversation, Ashley turned around, dropped her hands to her side, lowered her head and raised her eyebrows. She paused in her monologue about the definition of natural selection and stared directly at Brett: a stare Ashley describes as her death stare. Her face was stern, mouth held firmly in a straight line and she stood motionless as she glared at Brett. Brett raised his hands, palms outwards facing Ashley. He shook his hands slightly in a protest of his innocence. His facial expression was one of fear (Ekman 2003); his eyebrows rose slightly and his lips were parted but tense and stretched back horizontally. He commented at this point "I had nothing to do with it" (Excerpt 4, turn 01).

Excerpt 4 Brett is innocent

Turn	Speaker	Dialogue
01	Brett	I had nothing to do with it.
02	Ashley	Shh ((forceful utterance looking directly at Brett))

Ashley's utterance was said with force (turn 02). Her eyebrows were drawn together in anger, and the pursed lips of the utterance were quickly closed and tensed. Brett leant forward over his desk, lowered his head and fiddled with his pen. His gaze was focussed on his hands. He did not look up again for 22 s. At this point, Brett raised his head briefly and then settled his head onto his folded arms on the desk. He shut himself off from what was happening in the classroom; he did not write notes, talk or make eye contact with anyone. He remained in this position for further 17 min. This passive avoidance and withdrawal from social engagement indicates that in that moment, Brett did not feel safe, thus recruiting fight/flight mechanisms and possibly immobilisation behaviours.

During the cogen, Brett was asked about the interaction where Ashley chastised him in the belief that he had been talking. Brett expressed the following in Excerpt 5 (turn 01).

Excerpt 5 Brett "had enough"

Turn	Speaker	Dialogue
01	Brett	I had enough. She was just picking on me. I didn't even talk, and I was still angry about the, the whole gender thing. I wanted to leave but you can't just leave, you get suspended or something.
02	Researcher	Were you sleeping?
03	Brett	(laughs) No I just zoned out.

Brett's comment that he wanted to leave the classroom but couldn't because he might be suspended, may be interpreted as immobilisation when he "zoned out" choosing to stay in the classroom and not participate. Thus, according to PVT, when neuroception signals danger, social harm is possible (e.g. feeling angry and worrying about the consequences of being suspended) and involuntary shutdown and withdrawal will occur (Porges 2007). Brett's decision to withdraw from the class by "zoning out" appears to have been a voluntary decision in response to Ashley's "picking on" him.

Moving from immobilisation back to a safe zone

Fortunately, in the next lesson, Ashley sought out an opportunity to repair the relationship with Brett through engagement about the topic variations in populations. Students were talking amongst themselves, and some were interacting with Ashley and telling her their opinions, particularly regarding the idea that all people are descended from Africa, a notion raised by Sarah. Brett talked animatedly with Simon for over a minute, but none of the conversation was discernible on the video recording. When Ashley attempted to call

the class to attention, Brett spoke directly to Ashley about his thoughts regarding the variations of human skin colour across the world. Consistent with continuous neuroception, Brett felt that the social and physical environments were safe and thus he spoke for 16 s. During that time, Ashley maintained eye contact with Brett. Brett's voice was animated as he expressed his thoughts and Ashley reacted with positive sanctions by nodding her head, smiling and twice acknowledging Brett's ideas verbally; "Ah Ok" and "right".

Turner (2007) refers to such interactions as repair rituals where positive sanctions involving the words that were spoken, how they were spoken, body movements, gestures and facial expressions, seek to repair and normalise the interactions between people engaged in an interaction. Similarly, there is a cogen in Hsu's study where Vera explains her reasons for immobilisation leading to a repairing of the relationship with Ms. Karen. Immediately after the emergency cogen, the students discussed the cogen amongst themselves during lunch. Upon re-entering the laboratory, the students and scientists gathered together in a "cogen-like circle" to discuss the issues raised in the cogen. Vera had rejoined the group and participated in this discussion. Vera and Yasmine expressed their belief that asking questions of the scientists might be considered disrespectful, a belief found in their perception that teachers at their school would consider questioning to be disrespectful, as seen in the excerpt below:

Ms. Karen: **Why are you not telling me?** What would have been better about it? What was that DNA question, what was that about? I've been expecting this and craving this.

Vera: And that goes back to how I said that we don't want to upset you in any way. Because throughout high school, if we say something, it's like, "She doesn't want to be here and this and this, blah, blah." And I'm just like, "Okay, I'm sorry we pushed you. Sorry, master. Master, hit me."

Yasmine: I agree with Victoria, because I was like, she didn't say to explain what it does and this and that, but **I didn't want to be disrespectful.**

Thus, Hsu argues that Vera's immobilisation behaviours (not asking questions and being quiet) were a reflexive response to the unsafe environment. In this excerpt above, Vera explains why she was unable to express her concerns about the project leading to future cogens. The outcome was that "the Lucy incident" created dissonance between the students and mentors, but also helped them to communicate and reflect on how they were working together to do the project. The cogen helped explain the immobilisation but also enabled mobilisation as they moved forward with conflict resolution and reflection on practice to reach a safe environment where they could openly share their concerns. Thus, the structures and rules of social and communicative interactions in the group between scientists and students have been renewed and transformed.

Summary of findings from the two studies

In Hsu's study, cogen was used to discuss and address issues about the progress of a PBL science internship undertaken by nine secondary school students and scientists working at a university. Hsu's study highlighted the difficulty of enacting the rules of cogen, especially when the participants have varying degrees of power due to their roles in the institution and then are required to come together on an equal footing during cogens. In "the

Lucy incident”, the teachers responsible for mentoring and teaching the students, exerted authority and influence, breaching the cogen rules. The similar exertion of power by Ashley resulted in a failed cogen, where Ashley exerted her power in two differing ways, one prior to cogen and the other during cogen. The students in Ashley’s cogen were unwilling participants, and they were not actively engaged in dialogue during cogen. The balance of power lay with Ashley, as she imposed the direction of the conversation, and through probing questioning, did not encourage dialogue and equal turn-taking. A breach of the cogen rules by those in positions of power in both studies, led to unsuccessful cogens that did not create a shared understanding amongst participants or allow for the development and implementation of shared action plans.

During the emergency cogen after “the Lucy incident”, Vera, one of the internship students, was evidently upset, as she cried and withdrew herself from the conversation by leaving the room. Similarly, a classroom interaction between the classroom teacher Ashley and one of her students Brett in Oakley’s (2016) study resulted in behaviours where Brett withdrew from engaging with the teacher and other students. Both Vera and Brett did not perceive the social situation of cogen as safe, and thus the tools of social engagement were not accessible to them. Significant to both studies is if neuroception signals danger, social harm might be possible (e.g. Brett feeling angry and worrying about the consequences of being suspended; Vera believing that asking questions might be considered as “disrespectful” behaviour that deserves punishment) and the reflexive responses to the unsafe environment are to enact “immobilised behaviours”, such as not asking questions and being quiet (Vera) or being still and not writing notes, talking, or making eye contact (Brett).

The use of cogen, as an intervention tool, in Oakley’s study (2016), to transform difficult students’ inclusion in the classroom, provided a useful tool for educators to transform classroom interactions and classroom emotional climate. The implementation of cogen in an Australian school setting may prompt further research into the outcomes and possible benefits of teachers gaining a shared understanding with their students, of what is occurring in the classroom and how things could be done differently. In Hsu’s study, cogenerative dialogue enabled tensions between scientists and students to be resolved making the internship laboratory a safe place for all members.

Learning science in the middle years and particularly in the PBL environment can be a very emotional experience, and it can cause negative emotions, such as anxiety, anger, frustration and behaviour problems. Thus, both studies have highlighted the need for all stakeholders (scientists and teachers) to recognise the students’ emotions and the signs of students’ withdrawal and to act to understand the behaviour better. If the student is withdrawn for a prolonged period, it might be very difficult for the teacher or scientist to dampen the immobilisation circuit and enable the social engagement system to come back on line (Porges 2009). Emotional withdrawal can be detrimental to students’ success and if unresolved can lead to disengagement and reduced learning. Using cogen as a pedagogical tool can afford opportunities for teachers to address and transform the negative emotions between students. When students perceive the environment as socially safe, they will be able to communicate and share their concerns. Through action plans created by all members of the cogen that require accountability, further instances of heightened emotions may be ameliorated.

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