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Mediations Of Cogenerative Dialogues Between High School Students And Scientists

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MEDIATIONS OF COGENERATIVE DIALOGUES BETWEEN

HIGH SCHOOL STUDENTS AND SCIENTISTS

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MEDIATIONS OF COGENERATIVE DIALOGUES BETWEEN HIGH SCHOOL STUDENTS AND SCIENTISTS

by

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

The interest in science and whether students pursue science as a career is a highly discussed topic today. Research has shown that Science-Technology-Engineering-Mathematics (STEM) fields have displayed a significantly higher growth rate than employment in non-STEM occupations (Noonan, 2017). However, degrees earned in STEM have declined in the last few decades (Kuenzi, 2008). As the demand for STEM occupations rises, more students will need to pursue STEM. One way to maintain the STEM pipeline is to engage and inspire students at younger ages.

Science in today's classroom faces numerous challenges. Many students are learning directly from a textbook or a lab designed like a recipe. Such educational methods, designed to teach many students and concepts quickly with limited resources, do not allow authentic science to occur in the classroom (Domin, 1999). For instance, the lack of authentic science experiences for twelfth-grade students may be due to a shortage of science extracurricular experiences, lack of compelling science mentors, and limited hands-on inquiry activities with little meaning for students (Aschbacher et al., 2010). Current educational methods must continue to actively engage students toward STEM fields to meet our future workforce's demands. One approach shown to engage students toward STEM is through student-scientist partnerships with some benefits, including an authentic learning environment, improved knowledge of science, advanced facility access, and positive role models. Such partnerships are supported by using Cogenerative Dialogues to improve learning structures and a mediator to bridge the dialogues between students and scientists.

1.1 Benefits of Student-Scientist Partnerships

Traditional education methods may not fully provide students with engaging in scientific opportunities that could influence students to pursue a STEM career. However, one proven way that provides an authentic and engaging science environment for students is to place students into

a partnership with scientists (Bell et al., 2003; Charney et al., 2007; Hsu & Roth, 2010; Luehmann & Markowitz, 2007). In this partnership, students work directly with a scientist on a real project, fully immersed in the process of scientific inquiry (Aschbacher et al., 2010; Bell, Blair, et al., 2003; Burgin, McConnell, et al., 2015; Charney et al., 2007; Hsu & Roth, 2010; Knox et al., 2003). These collaborative environments demonstrate inquiry-based learning's success in generating interest in science (Atwater et al., 1999; Gibson & Chase, 2002; Hsu, 2008; Knox et al., 2003). Through inquiry-based learning, students actively learn in a hands-on and student-centered approach rather than traditional teacher-centered models (Burgin et al., 2015; Hsu & Roth, 2009; Knox et al., 2003; Markowitz, 2004). By allowing students to direct their learning and choose the topics they are interested in, student-scientist partnerships facilitate relevant, engaging, and authentic learning. (Hsu, 2008; Hsu & Roth, 2009; Hsu & Roth, 2010). Providing these opportunities is shown to improve students' understanding and knowledge of science (Beiers & McRobbie, 1992; Bell, Blair et al., 2003; Charney et al., 2007; Freedman, 1997; Hsu, Roth, et al., 2009; Leumann, 2009). These opportunities lead to positive impacts on students' understanding of science's nature (Burgin et al., 2012; Leumann, 2009).

Another benefit for students in partnerships with scientists is the possible development of mentee/mentor relationships that encourage their passion for science and provide a positive and personal mentor (Aschbacher et al., 2010). All of this culminates in an experience that motivates students toward scientific interests and careers in STEM fields (Atwater et al., 1999; Gibson & Chase, 2002; Hsu, 2008; Luehmann, 2009; Hsu & Roth, 2010). Furthermore, students are not the only ones to benefit from these partnerships; scientists also learn how their work can have an educational impact during these interactions (Hsu & Roth, 2010). Lastly, students in partnerships with scientists have access to facilities, tools, equipment, and practices uncommonly found in a

traditional school setting, providing a unique opportunity (Knox et al., 2003; Luehmann & Markowitz, 2007; Markowitz, 2004).

1.2 Challenges of Student-Scientist Partnerships

Student-scientist partnerships have demonstrated many various benefits as an authentic and engaging learning environment. However, interactions between students and scientists within this partnership may develop challenges. When students and scientists interact, the technical and academic language itself can become a barrier. Students unfamiliar with technical and academic language may become intimidated or confused. Language barriers may limit their level of engagement; meanwhile, scientists may feel frustrated by the lack of the student's prior knowledge or do not know how to modify their language for the developmental level of students (Hsu, 2008; Im & Martin, 2015; Wassel, et al., 2013).

Similarly, students who have not yet learned the necessary science and mathematical background and context to understand what the scientist is presenting may be a point of frustration for both the student and scientist (Kapon, 2016). Likewise, scientists may feel hesitant to allow inexperienced students to work in a lab setting with specialized equipment or projects with complicated and sensitive material. They may not have the maturity or skills necessary to take on such responsibilities (Hsu, 2008; Hsu & Roth, 2010). Moreover, high school students who experience university-level scientific experiments and procedures for the first time may be overwhelmed by the amount of time, effort, and repetition that projects require (Hsu & Roth, 2010).

At the same time, science educators find challenges with developing collaborations between students and scientists that pose relevant, meaningful, and authentic experiences in which students have the opportunity to collaborate with the scientist rather than just be an observer (Aschbacher et al., 2010; Ayendiz et al., 2011; Hsu, 2008). In some student-scientist programs,

limits on time frames and resources can also pose a challenge (Ayendiz et al., 2011; Hsu, 2008; Hsu & Roth, 2010). Though one way to engage students is to allow them to choose a topic they are interested in, some institutions are constrained by time, which directly impacts the ability to incorporate student choice (Burgin et al., 2012). If time is restricted, scientists' ability to stop and ensure understanding and address questions from students can likewise be limited (Hsu, 2008; Hsu & Roth, 2010). Lastly, underfunded schools can find it taxing to implement such programs due to their lack of resources, funding, facilities, time and training (Luehmann, 2009).

1.3 Potential of Cogenerative Dialogue

One possibility to address these challenges is to adopt cogenerative dialogue (cogen) into student-scientist partnerships. Cogen is a conversation between participants of a small group that elicits responses on experiences and generates shared decisions on responsibilities. Cogen strives to promote conversation between participants to develop a plan of action to change any learning structures that are not beneficial. In these small group meetings, critically evaluating current learning structures is encouraged to produce constructive feedback to develop improved strategies (Boss & Linder, 2016; Im & Martin, 2015; Shady, 2015; Tobin & Roth, 2005; Siry, 2011; Wassel et al., 2013). By providing a place and set time for students to feel comfortable expressing their concerns and ideas, cogen helps participants build confidence and ownership of their contributions (Tobin, 2006; Siry, 2011; Wassel et al., 2013; Harrison & Shi, 2016). Having students guide the cogen session helps develop a stronger sense of responsibility for their learning (Stith & Roth, 2010; Tobin, 2006; Wassel et al., 2013). Cogen builds on the idea of reflection. Participants are encouraged to reflect on their shared experiences to co-generate perspectives (Boss & Linder, 2016; Siry, 2011; Stith & Roth, 2010). Research shows that students who learn in a group setting encourage each other to elaborate their reasoning and

opinion through further questions and explanations, motivating and improving learning (Soller, 2001).

Though students may expect a traditional hierarchical structure, they are on equal footing with the teachers and scientists that are participating, which allows for positive relationships and a sense of community to grow (Bondi et al., 2016; Im & Martin, 2015; Tobin, 2006; Wassel et al., 2013). Cogen strives to eliminate the traditional hierarchal power structures expected within the student, teacher, and scientist interactions (Shady, 2015; Siry, 2011; Siry & Martin, 2014; Stith & Roth, 2010; Tobin, 2014). Thus, cogen is an essential channel to facilitate dialogue between students and scientists. However, some participants will find it challenging to break these perceived hierarchical power structures (Shady, 2015; Siry, 2011; Tobin, 2014).

1.4 The Need For Mediation In Cogen

When parties encounter conflict, a mediator is often helpful in resolving discord by being a third party who is not directly related to the dispute (Moore, 2014). Mediation has been essential in resolving conflicts between parties in legal settings; it first became popularized during the 1960s in labor-management and neighborhood disputes but quickly became an essential tool for traditional lawyers of domestic relations law (Alexander, 2008). Since then, mediation has migrated into many areas and has been an indispensable tool for educators. Mediation is an effective way to facilitate conversation in education due to traditional power structures between teachers and students (Engin, 2017). Also, mediators act as facilitators in directing conversations between parties, such as when they are uncomfortable expressing themselves in a group (Shreyer et al., 2010; Wegerif, 2008). Since interactions between students and scientists can be made more difficult by technical and academic language barriers, the level of current knowledge, and the intimidating interaction with a scientist, cogen is an essential tool

to encourage conversation between students and scientists. However, students and scientists may still experience difficulties in building a dialogue. Thus, the mediation of cogen sessions is essential in bridging the conversation between students and scientists.

1.5 Gaps to be Addressed

The use of cogen to develop educational structures is a topic that can expand through multiple areas and levels of education. The even-handed approach that engages everybody and allows all voices to be equally heard is a powerful tool for educators. However, initial experiences can be intimidating to participants, especially the students. Thus, having a mediator to bridge dialogue during a cogen session between students and scientists can be beneficial.

However, there is limited research on the mediation of cogen in student-scientist partnerships. The method used to determine current gaps in the research on mediations of cogenerative dialogues between high school students and scientists was done by finding the number of results returned when several key terms are searched for in scholarly databases. ERIC (Education Research Information Center; eric.ed.gov) and Google Scholar (scholar.google.com) were used to indicate gaps in the research. The benefits of using both combine the *Broad* reach that Google Scholar has and the specialized content that ERIC includes (Beel et al., 2009). Google Scholar has become one of the most used academic databases and includes only articles from "trusted sources and articles that are 'invited' (cited) by articles already indexed are included in the database. 'Trusted sources,' in this case, are publishers that cooperate directly with Google Scholar…" (Beel et al., 2009, p. 4). In addition, Google Scholar is frequently updated and includes a wide range of publications which include white papers, theses, dissertations, proceedings, technical reports, and citations of government reports (Jacso, 2009).

On the other hand, ERIC specifically databases educational research and is supported by the US Department of Education (ERIC, 2018). ERIC is the world's leading resource for literature related to educational research with over a million sources from research reports, journal articles, curriculum and teaching guides, and books (proquest.com). What ERIC lacks in diversity within its database, Google Scholar offsets. Using both databases to determine research gaps reveals a detailed view of the limited research on the topic.

"*Cogenerative Dialogue*," "*Mediation," "Student," "Scientist," and "Internship"* were the four chosen key terms to describe the scope of this research. Thus, these terms are used when determining gaps in research through search query analysis of popular scholarly databases. Various combinations of these four terms were applied through the two search engines to determine limits in the current research, expressed in Table 1.1 and Table 1.2.

Initial findings begin with using the key terms *"Cogenerative Dialogue"* and *"Student and Scientist"* to gauge the amount of literature available on the topics. In Table 1.1, it is shown that ERIC provides results for 68 articles relating to the keywords *"Cogenerative Dialogue."* This search demonstrates the sparse research currently on the subject within a database limited to educational research. However, Google Scholar provided 939 when searching the same keywords. Additional keywords in various combinations are queried to determine further the amount of current literature for "Cogenerative Dialogue." By including additional keywords, results showed that no articles under the keywords *"Cogenerative Dialogue" and "Student" and "Scientist" and "Mediation" and "Internship"* have been added to ERIC's database and a mere 12 results in Google Scholar. Of these twelve results, five are journal articles published from the "Work With a Scientist Program." One was from a research article implementing cogen (Henderson, Oakley, King, 2020). Two were from literature reviews, one from the journal

"Cultural Studies of Science Education" (Junior et al., 2014) and the other on "Cultural-Historical activity theory" by authors who have contributed to cogen research (Roth et al., 2009). Two results were related to the 2012 National Association for Research in Science Teaching (NARST) conference: one was the agenda which held four abstracts referencing cogen (Zeyer et al., 2012), and one had an abstract from the conference listed on the University of Hong Kong's website (Mataka et al., 2012). Lastly, one result cites an article by Kenneth Tobin, one of the leading researchers in cogen (Simon, 2012; Tobin, 2006). None of these articles have specifically researched mediation use within cogen between students and scientists.

Table 1.1. Search query results from ERIC using "Cogenerative Dialogue" as of October 2020.

	ERIC (eric.ed.gov)		***Google Scholar***	
Queried Term Searched for in Scholarly Database	*Results*	*Percentage*	*Results*	*Percentage*
"Cogenerative Dialogue"	68	100%	939	100%
"Cogenerative Dialogue" and "Student"	57	83.82%	828	88.18%
"Cogenerative Dialogue" and "Scientist"	2	2.94%	188	20.02%
"Cogenerative Dialogue" and "Mediation"	2	2.94%	158	16.83%
"Cogenerative Dialogue" and "Internship"	6	8.82%	131	10.87%
"Cogenerative Dialogue" and "Student" and "Scientist"	1	1.47%	182	13.95%
"Cogenerative Dialogue" and "Student" and "Mediation"	2	2.94%	145	15.44%
"Cogenerative Dialogue" and "Student" and "Internship"	6	8.82%	128	13.63%
"Cogenerative Dialogue" and "Scientist" and "Mediation"	0	0.00%	43	4.58%
"Cogenerative Dialogue" and "Scientist" and "Internship"	2	2.94%	52	5.54%
"Cogenerative Dialogue" and "Mediation" and "Internship"	0	0.00%	39	4.15%
"Cogenerative Dialogue" and "Student" and "Scientist" and "Mediation"	0	0.00%	43	4.58%
"Cogenerative Dialogue" and "Student" and "Scientist" and "Internship"	2	2.94%	52	5.54%
"Cogenerative Dialogue" and "Student" and "Scientist" and "Mediation" and "Internship"	0	0.00%	12	1.28%

However, *"Student" and "Scientist"* ERIC has over five-thousand results. Google Scholar has over a million results, as seen in Table 1.2. There is currently no literature related to *"Student" and "Scientist" and "Cogenerative Dialogue" and "Mediation" and "Internship"* within ERIC's database and less than 10 in Google Scholar. Together, these results demonstrate a gap in research on the topic of cogen mediation in student-scientist partnerships. This research will attempt to bridge this gap by addressing how mediators mediate in a cogen session between students and scientists.

Table 1.2. Search query results from ERIC using "Student and Scientist."

	ERIC (eric.ed.gov)		***Google Scholar***	
Queried Term Searched for in Scholarly Database	*Results*	*Percentage*	*Results*	*Percentage*
"Student" and "Scientist"	5,786	100%	1.95 million	100%
"Student" and "Scientist" and "Cogenerative Dialogue"	2	0.03%	182	0.01%
"Student" and "Scientist" and "Mediation"	10	0.17%	75,800	3.89%
"Student" and "Scientist" and "Internship"	54	0.93%	37,900	1.94%
"Student" and "Scientist" and "Cogenerative Dialogue" and "Mediation"	2	0.03%	43	0.00%
"Student" and "Scientist" and "Cogenerative Dialogue" and "Internship"	6	0.10%	52	0.00%
"Student" and "Scientist" and "Cogenerative Dialogue" and "Mediation" and "Internship"	0	0.00%	12	0.00%

Thus, the research question for this thesis:

What styles of mediation are demonstrated in cogenerative dialogue in the course of a high school student's science internship?

The purpose of this thesis is to analyze mediation within cogen sessions using the framework of Riskin's (2003a) mediation orientations to understand the various mediation styles used between students and scientists during cogen.

Chapter 2: Literature Review

2.1 Student-Scientist Partnerships

Placing students into a partnership with scientists has been proven to be a successful method to provide an authentic and engaging science learning environment (Bell et al., 2003; Charney et al., 2007; Luehmann & Markowitz, 2007). Within these partnerships, it has been shown that inquiry-based learning projects generate student interest in science (Atwater et al., 1999; Hsu, 2008; Gibson & Chase, 2002; Knox et al., 2003). Also, Student-Scientist partnerships have been shown to improve students' understanding and knowledge of science (Beiers & McRobbie, 1992; Bell et al., 2003; Charney et al., 2007; Freedman, 1997; Hsu et al., 2009; Leumann, 2009), which has a direct and positive impact on students' understanding of the nature of science (Burgin et al., 2012; Leumann, 2009). Further, an added benefit of working with scientists is the opportunity to have access to facilities, tools, and equipment uncommonly found in a traditional setting (Knox et al., 2003; Luehmann & Markowitz, 2007; Markowitz, 2004).

In a student and scientist partnership, students have an opportunity to work directly with a scientist on a real project that fully immerses the students in the process of scientific inquiry (Aschbacher et al., 2010; Bell et al., 2003; Burgin et al., 2015; Charney et al., 2007; Hsu & Roth, 2010; Knox et al., 2003). In most cases, student scientist partnerships use inquiry-based learning to shape their project by allowing students to learn in a hands-on activity and student-centered approach rather than through traditional teacher-centered models (Burgin et al., 2015; Hsu & Roth, 2009; Knox et al., 2003; Markowitz, 2004). Moreover, the scientist's projects in a student-scientist partnership can be provided as a real research project (Charney et al., 2007). A student's interests are prioritized during placements with scientists (Burgin et al., 2012). Further, when allowing students to direct their learning by choosing their project, student-scientist partnerships

facilitate relevant, engaging, and authentic learning (Hsu, 2008; Hsu & Roth, 2009; Hsu & Roth, 2010).

By providing students the opportunity to work directly with a scientist, positive and personal role models are established, which encourages their passion and interest in science. (Aschbacher et al., 2010). Positive role models are essential for a student's development because they encourage students to emulate their behavior, fostering a student's interest in science (Canes & Rosen, 1995). In addition to students benefitting from student-scientist partnerships, scientists also can experience how their work can have an educational impact (Hsu & Roth, 2010). Therefore, benefits of student-scientist partnerships (i.e., authentic learning environment, knowledge of science, facility access, and positive role models) culminate in experiences that motivate students toward scientific interests and careers in the STEM field (Atwater et al., 1999; Gibson & Chase, 2002; Hsu, 2008; Hsu & Roth, 2010; Luehmann, 2009).

In a student-scientist partnership, technical and academic language can pose a challenge to both parties. On the one hand, encountering technical and academic language may be intimidating or confusing for students for the first time. Thus limiting the level of engagement; on the other hand, scientists can become frustrated with the lack of understanding and need to modify their language to match the level of understanding of their audience (Hsu, 2008; Im & Martin, 2015; Wassel et al., 2013). Another challenge encountered in student-scientist interactions is the differing levels of knowledge, such as a high school background in science versus a chemistry Ph.D. For instance, both parties' frustration forms if a student has not learned the science and mathematical material necessary to understand what the scientists are trying to explain (Kapon, 2016).

Moreover, these students may also be unfamiliar with university-level science experiments, processes, and the work required for these projects (Hsu & Roth, 2010). Thus, scientists may limit the interaction students may have with sensitive and complex projects (Hsu, 2008; Hsu & Roth, 2010). Even though the scientific practices that a scientist presents to students are authentic, it is only relevant to students if it is adapted to the student's capabilities (Lee & Butler, 2003).

The educators who develop the programs for student-scientist partnerships are challenged to create relevant, meaningful, and authentic experiences that allow students to actively engage in their partnership rather than as an observer (Aschbacher et al., 2010; Ayendiz et al., 2011; Hsu, 2008). Limited time and funding resources can significantly challenge student-scientist partnership programs (Ayendiz et al., 2011; Hsu, 2008; Hsu & Roth, 2010). To illustrate, underfunded institutions may find it difficult to implement programs due to a lack of resources (Luehmann, 2009). In another regard, though allowing a student to choose their topic of interest is regarded as an effective form of engagement, the time an institution is allotted can impact students' autonomy in their choices (Burgin et al., 2012). Moreover, time can also impact scientists' ability to stop and address confusion among students and answer questions (Hsu, 2008; Hsu & Roth, 2010).

2.2 Cogenerative Dialogue

Cogen is a group discussion between participants that encourages reflection and provokes responses on shared experiences, generating shared decisions on responsibilities. During cogen, the goal is to improve the learning environment through small group meetings that strive to evaluate learning structures by discussing issues critically, produce constructive feedback and solutions, and reflect on positive experiences (Boss & Linder, 2016; Im & Martin, 2015; Shady,

2015; Tobin & Roth, 2005; Siry, 2011; Wassel et al., 2013). One of the founding ideas of cogen is the process of reflection, which encourages participants to reflect on their personal and shared experiences and to co-generate perspectives (Boss & Linder, 2016; Siry, 2011; Stith & Roth, 2010). In cogen, shared experiences between participants are evaluated by reflecting on the teaching-learning activities, focusing not on a single person but all participants (Tobin & Roth, 2005). Cogen is conducted ideally in small groups of 4-6 with the idea that each group member will represent different groups within a classroom (Emdin, 2011). The understanding or rules within the group during a cogen session is that each person has an equal right to a turn, everyone must show respect and listen to others, different perspectives are expected and valued, and an action plan must be decided on to be used in further practice (Emdin, 2011).

Learning in groups has been an effective means of encouraging students to engage through asking questions, explaining and validating their opinions, discussing their reasoning, and expanding and reflecting upon their knowledge, which motivates and improves their learning (Soller, 2011). Cogen sessions allow students to express their concerns and ideas, which allows students to develop a sense of personal voice (Harrison & Shi, 2016; Siry, 2011; Tobin, 2006; Wassel et al., 2013). By allowing students to guide the direction of the cogen session, it has been shown that students develop a stronger sense of responsibility for their learning (Stith & Roth, 2010; Tobin, 2006; Wassel et al., 2013). Cogen sessions allow traditional hierarchical structures to be broken by placing all participants on equal footing. This in turns builds positive relationships and a growing sense of community (Bondi et al., 2016; Im & Martin, 2015; Shady, 2015; Siry, 2011; Siry & Martin, 2014; Stith & Roth, 2010; Tobin, 2006; Tobin, 2014; Wassel et al., 2013). However, participants may feel uncomfortable breaking these perceived barriers

(Shady, 2015; Siry, 2011; Tobin, 2014); barriers can be based on differing genders, ages, ethnic, cultural, economic, and social backgrounds (Stith & Roth, 2010; Tobin & Roth, 2005).

Cogen can face other challenges brought on by the time and resources available. In some cases, teachers felt that they had limited time to conduct an effective cogen session with their students outside of the classroom (Boss & Linder, 2016; Im & Martin, 2015; Marin, 2006; Siry, 2011). Moreover, teachers also lacked the training and support necessary to implement cogen in their classrooms (Boss & Linder, 2016; Im & Martin, 2015; Stith & Roth, 2010).

Though cogen may experience challenges, the impacts far outweigh any negatives. For example, in one study in which cogen was being used to collect data, the researchers discovered other impacts on their students.

> [T]he dialogues had potential to be powerful tool for teachers to engage students in conversations aimed at improving teaching and learning. The dialogues privileged the students' voices. For many students, this was the first time they had been asked their opinion about school, teaching, or learning. Ultimately, the dialogues became a space for positive change and transformation derived from students' perspectives. (Wassel et al., 2013, p. 726).

The impact of further providing students an opportunity to engage in their learning process is a trend when using cogen with students and teachers (Bondi et al., 2016; Elmesky & Tobin, 2005). Similarly, the student interactions during cogen have shown to build positive relationships and experience different perspectives than their own (Bondi et al., 2016).

2.3 Mediation

Mediation is the act of a third-party person guiding a dialogue between conflicting parties toward a resolution. The person conducting the mediation is the mediator. Even though mediation is more popularized in a legal setting, it is a beneficial practice that can be implemented during any conflict that we encounter in our daily lives. The nature of mediation itself leads it to be a vital process in education (Engin, 2017; To & Liu, 2017). Thus, a mediator is often helpful in situations in which parties find difficulty talking with one another over a conflict; this discord can be bridged by a third-party person not directly related to the dispute (Moore, 2014). For instance, Riskin (1996) explains how mediation's principal goal is to provide opportunities for participants to grow and learn.

Mediation has ancient roots in China through Confucian beliefs that conflict resolution was best found through moral persuasion and agreement (Folberg, 1983). The United States began to embrace mediation during the 1960s between labor-management relationships in which parties looked for alternative dispute settlements than traditional litigation (Folberg, 1983). As divorce became more common in the 1970s, attorneys saw the opportunity to resolve conflicts between parties without giving legal advice (Folberg, 1983). Thus, mediation has since become an essential part of the legal system and has migrated into many other areas, including education.

There are many different forms of mediation, with varying methods being used to help resolve conflicts. For one, the focus of "*evaluative mediation"* is to provide parties with an evaluation of their case, which can help direct the outcome of their settlement; this could include discussing the weaknesses of a case and what a judge or jury may decide (Zumeta, 2000). Another, "*facilitative mediation*," is about placing the responsibility for the outcome on the participants while the mediator oversees facilitating the process of mediation (Zumeta, 2000).

Another example, "*transformative mediation*" is based on empowerment and recognition; participants recognize and analyze situations that they have the power to transform and allows for the capacity to consider others' perspectives (Folger & Bush 1996). Unlike other forms of mediation, "*narrative mediation*" is based on constructing personal stories to better understand ourselves and others; people naturally tend to organize experiences in a narrative form (Baraldi & Rossi, 2011; Winslade & Monk 2000).

Similarly, in Bakhtin's theory of *dialogic discourse*, the speakers' perspective is reflected by their voice, which accommodates many viewpoints, fundamental in "human meaning-making" (Fernyhough, 2008). Specifically, this form of mediation requires equity and empathy, which allows for the acceptance of diversity (Baraldi & Rossi, 2011). Alternatively, Orland-Barack (2006) described "*convergen*t" and "*divergent*" dialogue in which mediators directed the conversation toward a solution or to depart from the topic. In another example, Chien (2016) described the mediator's role as being a professional dialogue facilitator who guides the conversation, ensuring that progress is made as the agenda is followed (Table 2.1).

Mediation is a useful tool in education due to facilitating conversation between teachers and students (Engin, 2017). Mediators are also helpful in directing conversations when participants are uncomfortable in expressing themselves in a group (Shreyer et al., 2010; Wegerif, 2008). However, mediation also benefits participants personally by allowing them to construct an identity, expand their understanding of ourselves and others, and nurture rational communication practices (Burbules & Rice, 1991).

Table 2.1. Mediation forms and examples.

Mediation Form	***Definition***
Evaluative Mediation (Zumeta, 2000)	Provides parties with an evaluation of the outcome of a case
Facilitative Mediation (Zumeta, 2000)	Facilitating the process of mediation and allowing participants to be responsible for outcomes
Narrative Mediation (Baraldi & Rossi, 2011; Winslade & Monk, 2000)	Constructing personal stories through a natural narrative organization lets others understand our experiences better.
Dialogic Discourse (Baraldi & Rossi, 2011; Fernyhough, 2008)	Perspectives reflected by the personal voice of the speaker
Convergent/Divergent Mediation (Orland-Barack, 2006)	Directing conversation toward solutions/Departing from a topic

Due to the nature of a mediator's role, mediators can find difficulty in maintaining a sense of peace while working with a group of people involved in a conflict (Bowling, & Hoffman, 2000). Mindfulness is often encouraged and practiced by mediators to help with the challenges of working with conflicting individuals (Larkin-Wong, 2012; Riskin, 2004). Though mediation may be a natural process for some, others require training to be effective in their role (Shoffner & Williamson, 2000). In some programs, training is conducted in three stages: first, teaching how to restate and reframe the participant's dialogue; second, explaining why restating and reframing is valuable; and lastly, developing a deeper level of personal connection with the participants (Bowling & Hoffman, 2000).

2.4 Theoretical Framework: Riskin's Mediation Grid

Leonard Riskin (1996), who has written extensively about mediation within the legal system, developed a means to categorize and to understand mediation in all its varied forms. He employed a grid in which mediation styles were organized along two axes, by the problem and the style. Problems are defined as either *narrow* or *Broad*, meaning they affect individuals or whole communities. Initially, the style of mediation was divided by either *facilitative* or *evaluative*. *Facilitative* describes mediation in which the mediator helps participants communicate and understand one another, and *Evaluative* describes a mediator who directs some or all the outcomes of mediation.

However, many other mediation researchers have argued against this grid system, stating that evaluative mediation is not beneficial within a legal setting (Booker, 2007; Hesser & Craig, 2007; Kovach & Love, 1996; Kovach & Love 1998; Love & Kovach, 2000; Love & Waldman, 2016). In one case, Kovach and Love (1996) argued that evaluative mediation leads toward favoring one party over another rather than providing solutions to a problem. On the other hand, others contend that the controversy behind Riskin's Grid is that it demonstrates that mediators must maneuver through the often-muddy waters of emotion, law, and finance (Hesser & Craig, 2007). Still, others have argued that the chosen terminology of Riskin's Grid (1996), evaluative and facilitative, can be confusing and lead to misconceptions on the methods of mediation (Love & Kovach, 2000). Finally, some have suggested that because Riskin's Grid (1996) legitimized evaluative mediation, mediation lost its emphasis on "understanding, problem-solving, and party engagement" (Love & Waldman, 2016, p. 138).

In response to the controversy created by his publications, Riskin (2003a; 2003b) redesigned his grid. In 2003, Riskin changed the grid's language, replacing *Facilitative* with *Elicitive* and *Evaluative* with *Directive*. As an explanation for the change in language, Riskin (2003a) stated that "using the terms '*Directive*,' and '*Elicitive*' also can help us recognize that mediators can direct (or push) the parties toward particular outcomes..." (pp. 31-32). The term *Elicitive* implies that a mediator is drawing a response from the participants (Riskin, 2003a; Riskin, 2003b). Though these terms are similar to the originals (Riskin, 1996), they enhance the description for each and emphasize two distinct methods of mediation. However, Riskin advises readers that this mediation gird is static, does not represent the dynamic nature of mediation, and ignores the parties' roles and influence (Riskin, 2005). Figure 2.1 demonstrates the relationship between each quadrant of the theoretical framework and the definitions of each.

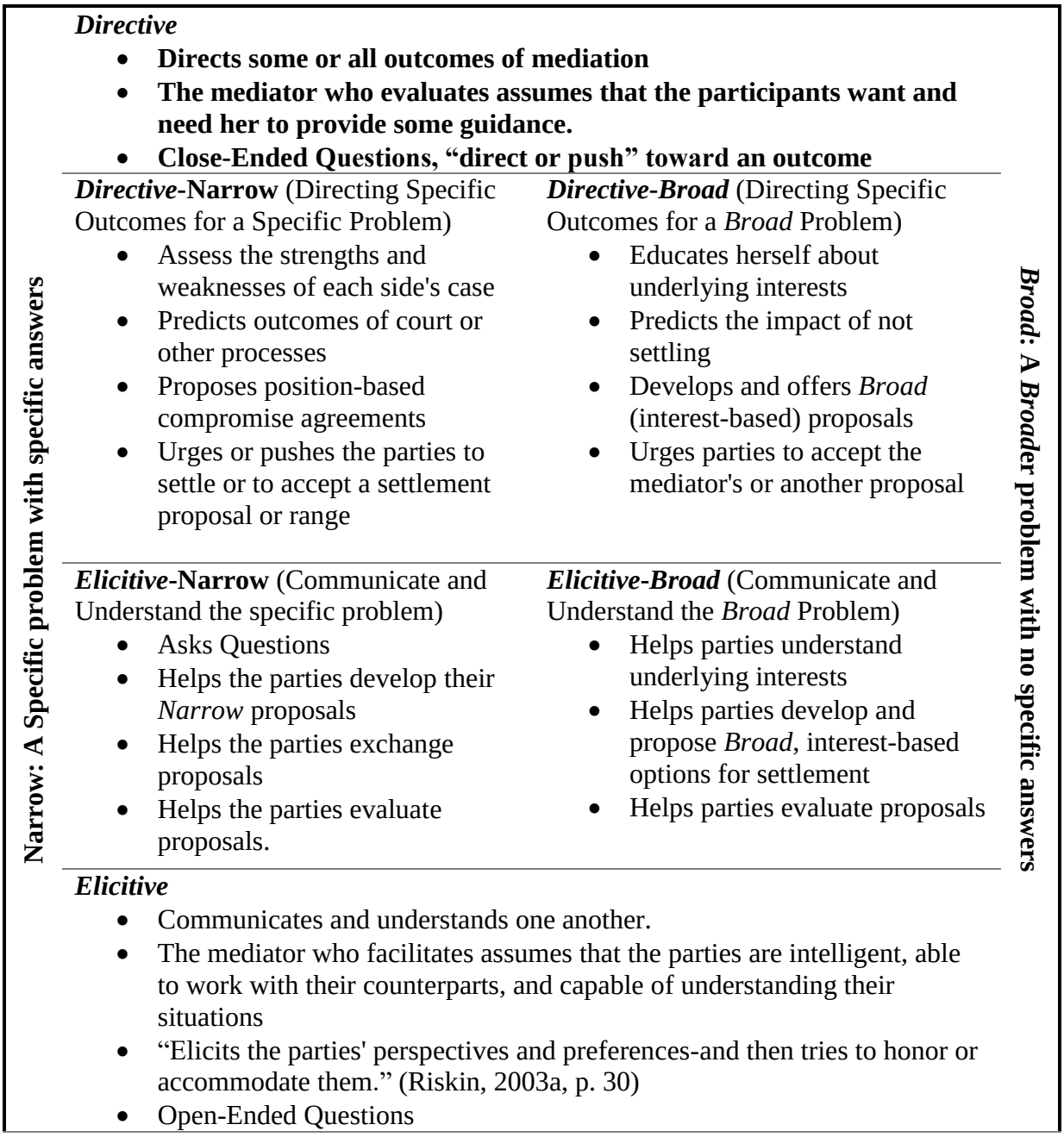


Figure 2.1. Riskin's mediation grid summary of mediation styles (Riskin, 1996; Riskin, 2003a; Riskin, 2003b).

Chapter 3: Methodology

Data collected in this thesis uses existing data from the Transforming Students' Partnership with Scientists Through Cogenerative Dialogues project, also known as the Work with a Scientist Program (WWASP). This project was funded through the National Science Foundation (Project No DRL 1322600) and conducted at the University of Texas at El Paso (UTEP). WWASP is a program designed to provide high-school students the opportunity to collaborate with university scientists from UTEP in advanced scientific research. WWASP uses cogenerative dialogues to connect students and scientists in reflective conversations about their experiences with the program.

3.1 Participants

The region's culture is predominantly Hispanic and considered economically disadvantaged. Recruitment of students for the WWASP was first conducted through presentations by program staff members at three local high schools for all incoming 11th-grade students. The presentations included an overview of the program, application requirements, a copy of the syllabus, an explanation of the stipend, and transportation logistics. Science teachers partnered with the program are provided flyers to pass out to students and posters to post around the school to encourage interest in the program. Interested students that met the criteria complete and submitted the application through their science teacher to program staff. Each of the applications is reviewed by an evaluative committee with a minimum of two members reviewing each application. Students must hold at least a 3.0 GPA (based on a 4.0 scale) and be incoming 11^{th}-grade high-school students. Students selected also needed to demonstrate that they were committed to the program without any interfering obligations.

Of the students that applied, 36 were selected to participate in the program. Students were expected to conduct field and laboratory investigations for at least 40% of the time. These investigations were deemed safe, environmentally appropriate, and ethical. In their investigations, they used a systematic approach in answering scientific investigative questions.

Four scientists from the university were recruited to participate in the program. Each scientist could accommodate up to nine students; this determined the total number of 36 students who participated in the program. Students were then divided randomly into four different lab groups under each scientist and divided further into smaller groups of 2-3 students within the lab. Each scientist was expected to instruct students and guide them through their research projects. The participating scientists had a wide range of backgrounds: Biology and Biomedicine, Clinical Laboratory Sciences and Interdisciplinary Health, Chemistry, and Biological Sciences. Each of the scientists was aided by 2-3 science Teaching Assistants (TA's) who provided support and guidance in the lab for students and scientists and participated in cogen sessions.

Those selected as mediators for cogen sessions were research assistants (RA's) working in the WWASP office. They were trained and tasked to mediate cogen between students and scientists to improve science practices. Also, the mediators assisted in laboratory activities to support the students and scientists. Two RA's were involved in each lab, one to mediate cogen, one to film the group's activities.

The mediator for Lab 1 (M1) was an undergraduate senior who was majoring in Speech-Language Pathology (Table 3.4.0). The mediator for Lab 2 (M2) was an undergraduate sophomore majoring in engineering. M2 reported that English was not their first language. The mediator for Lab 3 (M3) was an undergraduate Junior majoring in Education and reported

English as not their first language. The mediator for Lab 4 (M4) was an undergraduate Junior with a major in chemistry and reported that English was not their first language.

Table 3.4.0 Mediators who participated in the study, their class standing, major, and language.

Lab	*Mediator*	*Class Standing*		*Major*	*ESL*
1	M1	Undergraduate	Senior	Speech-Language Pathology	No
2	M2	Undergraduate	Sophomore	Engineering	Yes
3	M3	Undergraduate	Junior	Education	Yes
4	M4	Undergraduate	Junior	Chemistry	Yes

3.2 Work with a Scientist Program

In the spring semester of 2015 (January-May), students participated in the program once a week for ten weeks on Saturdays. Students attended science activities with their assigned scientist for two hours during these Saturday afternoons, participated in a cogen session for one hour, and met with their high-school teacher of record for half an hour. Students met for 30 weekdays, six hours a day during summer, in June and July, with one-hour cogen sessions on Tuesdays and Thursdays. The four separate lab groups were running simultaneously under each of the four scientists in different laboratories.

The program expected students to gain contextualized knowledge on current and ongoing projects at UTEP, improve their scientific thinking and research skills, develop teamwork and professional communication skills, and make a habit of safe laboratory work practices.

3.3 Data Sources

Each cogen session is video recorded to capture interactions, body language, the tone of voice, and other nuances not apparent in a transcript. The students attended 41 total days with four different labs running simultaneously. Of those days, around 20 cogen sessions occurred per lab. Thus, over 80 total cogen sessions were recorded. The recorded cogen sessions are transcribed with participants' names coded to ensure discretion and confidentiality.

3.4 Data Analysis

The purpose of this research was to analyze mediation within cogen sessions between students and scientists. To accomplish this, Riskin's Mediation Grid (Riskin, 1996; Riskin, 2003a; Riskin, 2003b) is used as a framework to identify mediation orientation styles. Riskin (1996; 2003a; 2003b) defines four mediation styles through problem scope and mediation method.

3.4.1 Defining *Elicitive* and *Directive*

Mediation methods were divided by *Elicitive* and *Directive*. In *Elicitive* mediation, the mediator encourages participants' perspectives, helps communicate, understand each other, and asks open-ended questions. In *Directive* mediation, the mediator guides participants toward some or all outcomes and asks closed-ended questions. The following Table 3.4.1 demonstrates a summary of *Elicitive* and *Directive*.

Table 3.4.1 Summary of *Elicitive* and *Directive* mediation adapted from Riskin (2003a; 2003b).

Elicitive	***Directive***
The mediator initiates a participant-led discussion by asking open-ended questions. Participants clarify what they understand and provide solutions.	The mediator initiates the discussion by directly asking specific close-ended questions. Participants respond with brief answers. The mediator evaluates the response of the participants and directs the dialogue further. The mediator may provide a solution rather than the participants.

During the initial analysis of cogen, the consistency of each mediation style's interpretation became a focal point to ensure that others could replicate similar results. In a similar research study by Golann (2000), the challenges of analyzing mediation styles during a legal dispute using the Riskin Grid (1996) was discussed. To address this challenge, Golann (2000) adapted the Riskin Grid (1996) to include additional parameters to define problems and

mediation styles (*Facilitative* and *Evaluative*). Similarly, additional parameters were added to the definitions of *Elicitive* and *Directive* for this analysis (See Figure 3.1)

To analyze the cogen session with the framework, the definitions of mediation style had to be established. In the cogen dialogues, naturally occurring statements and questions are used to communicate. Thus, questions and statements were used to define *Elicitive* and *Directive*. In *Directive* mediation, the mediator's task is to help direct participants toward solutions, while *Elicitive* mediation encourages participants' responses and allows the participants to be responsible for solutions. Thus, an *Elicitive* statement made by the mediator will demonstrate an acknowledgment, a response, an agreement, a confirmation, or will further prompt participants for elaboration; and a *Directive* statement made by the mediator will demonstrate a disagreement, provide the mediator's perspective, an assumption by the mediator, an evaluation of a participants perspectives, a suggestion, or gives directions (See Table 3.4.2 and Table 3.4.3 for examples.)

Secondly, whether a mediator uses an open or closed-ended question to initiate cogen determines the mediation style used. Open-ended questions invite participants to answer questions with their own words and opinions; unlike close-ended questions, open-ended questions are not structured to direct someone toward a singular answer (Züll, 2016). For example, a close-ended question would have a simple answer: "What is your name? Steve. Did you enjoy the book? Yes. What is the answer to two plus two? Four."

On the other hand, an open-ended question allows for more elaboration by the participant: "What does your name mean? What did you enjoy about the book? How did you find the answer to two plus two?" Typically, an open-ended question uses terms such as how and why. However, an additional form of close-ended questions were revealed during the initial analysis, close-ended questions with the intent to elicit further dialogue: "Have we discussed everything? Does everybody agree?" The participant would answer the close-ended question

with a brief answer and elaborate on the answer without any further prompting by the mediator. Thus, *Elicitive* mediation, which strives to communicate and understand one another, would use open-ended questions to initiate the response of perspectives and dialogue of the participants or a close-ended question that elicits responses that further elaborate and clarify; while *Directive* mediation would only use close-ended questions to direct and guide the conversation or ask for judgment or evaluation (see Figure 3.4.2 for definitions Tables 3.4.3 and 3.4.4 for examples).

3.4.2 Defining *Broad* and *Narrow*

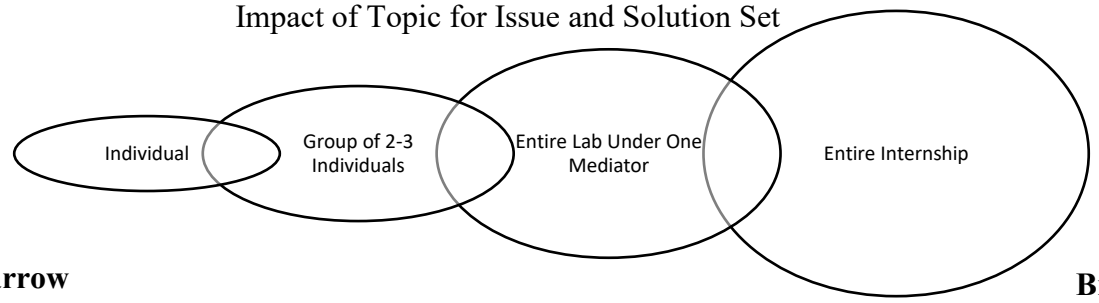
To define the difference between a *Narrow* problem and a *Broad* problem, research on how Riskin (1996) defined the continuum between the two was investigated. *Narrow* problems are described as affecting individuals, while *Broad* is affecting entire communities or industries. In general, this was interpreted as *narrow* relating to individuals, while *Broad* referred to the community. To apply this definition to the internship, *narrow* was defined as being individual students or small teams of students and the *Broad* community as being the whole lab under one mediator or everyone participating in the internship. Thus, the topic of each issue and solution set within cogen was the focus for the *broad* and *narrow* continuum. (See Figure 3.1 for flow; See Table 3.4.2 for examples) These categories ensure that the overall topic of an issue and solution set can be categorized based on their impact.

Elicitive

Questions: the mediator asks open-ended questions; or a close-ended question with an open elaborated response, or asking for clarification?

Statements: the mediator makes an acknowledgment; a response; an agreement; a confirmation; summarizes; or prompts for further elaboration

Impact of Topic for Issue and Solution Set



Narrow **Broad**

Questions: the mediator asks close-ended questions with a response that is an evaluation or judgment

Statements: the mediator disagrees; provides own perspective; makes an evaluation; suggests, or gives a direction

Directive

Figure 3.1. Cogen mediation grid with definitions of questions and statements.

Table 3.4.2 Examples and definitions of *Broad* and *Narrow* mediation.

	Broad (B)	*The topic of the problem is focused on an entire Lab or affects the whole Internship*
A	Lab Safety (an issue identified across all labs)	
B	Communication between students, mediator, research assistants, and scientists (an issue identified across all labs)	
C	Buses arriving late (an issue identified across all labs)	
D	Not a large enough space for one lab to meet to conduct cogen (Identified only in Lab 4)	

	Narrow (N)	*The topic of the problem is focused on an individual or a group of 2 or 3 students*
A	Students sleeping during the internship (identified in one group of Lab 1)	
B	Some students finding pouring liquids in the lab difficult (Identified in one group of Lab 2)	
C	A student unable to see projection from where they were seated (Identified in Lab 1)	
D	Some students struggling to keep useful notes (Issue identified in Lab 4)	

Table 3.4.3. *Elicitive* mediation definitions of questions and statements, and examples.

Elicitive Questions		*The Mediator Asks Open-Ended Questions*
1	M^k	Does anybody else have anything to add to that, like why that would happen? Why maybe as a student that you would be more just receiving information, like why would that be something that people do? (Open-ended question)
2	M^k	What issues or concerns do you have today? (Open-ended question)
3	M^k	Does anybody have the other side of why we needing to participate and ask questions as an entire group is beneficial? (Open-ended questions)
		The Mediator asks a Close-Ended Question that elicits a clarification or perspectives, can have an open and elaborated response
1	M^k	Do you guys usually have your teachers tell you when to write stuff in your notebook, or are you choosing not to write in your notebook?
	S^t6	Well, usually they tell us what to write. Or, like me, I cannot write that fast. I have it repeated so I can write it in my notebook. (Question is closed ended, asking for perspectives of the group to better understand)
2	M^k	Did you say rotation of the tables?
	S^t3	Yeah, and rotate each group into different areas. (Question was closed ended, asking for clarification)
Statements		*The Mediator makes an acknowledgment; a response; an agreement; a confirmation; summarizes; or prompting further elaboration*
1	M^k	Okay, yes, that was good. (Statement is an acknowledgement and confirmation)
2	M^k	Okay. So, what I'm hearing for the solution is that we need to be asking more questions, asking why if we don't understand but in conjunction with making sure that it's because we're being attentive and just simply let's say if we just don't understand, to be clearer. (Summarizes the discussion by the participants on a solution)
3	M^k	Okay, the one thing since we decided it's not an issue until it becomes an issue, we'll discuss it then. But they'll do the best to accommodate. (Summarizes the discussion by participants on a solution)

M^k: Mediator S^t#: Students T^a#: Teaching Assistant S^c: Scientist

Table 3.4.4 *Directive* mediation definitions of questions and statements, and examples.

Directive		
Questions		*The Mediator Asks Cl.ose-Ended Questions that may direct a judgement or evaluation as a response*
1	M^k	Bring the whiteboard?
	S^t1	Yeah
	M^k	Is that something you can do, is the whiteboard always there?
	T^a1	Yeah, its moveable (Questions are close-ended with close-ended responses)
2	M^k	So the one thing since we decided it's not an issue….Is that fair?
	All	Yes. (Question is close-ended, asking for a judgment on a solution from group)
3	M^k	How did this cogen go for y'all?
	S^t6	Great
	S^t3	Amazing
	S^t4	Awesome (Question is close-ended, responses are an evaluation of cogen)
Statements		*The Mediator disagrees; provides own perspective or assumption; makes an evaluation; makes a suggestion; or gives a direction*
1	S^t3	I remember one of my teachers tried making us… do the [Cornell Notes]…and…that's the way to do notes, and that is how everyone [does] notes. And then I didn't understand how to do them.
	M^k	Because you like to draw pictures (Makes an assumption)
2	M^k	Here is a solution for our problem. We will all be open-minded and use critical thinking skills, and to be active participants (Provides a solution).
3	M^k	What I want you all to do is find things that you have in common - volunteer work, if you donate, if you work out in your community (Gives a direction).

M^k: Mediator S^t#: Students T^a#: Teaching Assistant S^c: Scientist

In the following Table 3.4.5, a step by step guide on how to code each mediator's turn as *Directive* or *Elicitive* is demonstrated. To read this table, start with line 1, "Is the mediator's turn a…" In section one, three questions are asked; is this a question, a statement, or a filler. If it is decided that the turn is a filler, such as a "hmmm," "U-huh," or "Ahem," this turn will not be coded. If the turn is decided that it is a question, the next step is to go to section 2 of the table.

For section 2, the guide asks if the mediator's question is open-ended (coded as *Elicitive)* or close-ended (prompts to go to section 3). This continues until a code has been decided for each turn.

Table 3.4.5 Step by step guide on how to code each mediator's turn and examples.

1	**Is the mediator's turn a….**	**Example**	
1a	Question?		*Go to 2*
1b	A statement?		*Go to 4*
1c	A filler.	"Hmmm" "U-huh" "Ahem"	**Do not code**
2	**Is the mediator's questions…**		
2a	Open ended? The question is phrased in a way that requests for a response that provide reason, explanation, and elaboration.	"*What* issues or concerns *do you* have today?" "So, *what happened* there? *What do you mean* about the procedure?" "*Why do you think* this is an issue?"	***Elicitive***
2b	Closed ended?		*Go to 3 (Table 3.6)*

Table 3.4.6 Continued from Table 3.4.5, a step by step guide on how to code each mediator's turn and examples

3	**Review the response to the question. Does the mediator receive a response that is…**		
3a	Answers with a short, closed response that is specific (A closed-ended question that receives a specific or brief one to several word answer.)	Mediator: "This is respect, *right?* We're family?" Student: "Yes." Mediator: "*Does everybody agree*?" Students: "Yes!" Mediator: "So, *does everybody agree* the issue is that not having snacks - is that an issue?" Students: "Yes" Mediator: "So you're open to the possibility of stepping out [of your comfort zone]?" Student: "I'm really open to the options."	***Directive***
3b	Answers with a short, closed response that is specific but offers elaboration, reasoning, and/or clarification. (A closed-ended question that encourages the dialogue to continue)	Mediator: "So be an active participant is what you're saying?" Students: "Yes, because…." Mediator: "*Do you think* it's beneficial at all?" Student: "I think it's beneficial, because we can all be on the same page and we can all understand where each person is coming from, and we can all ask questions, like, "Oh, well, if it's--" let's say, for example, he has a different perspective on what we're learning,"	***Elicitive***
3C	A closed-ended question that is asking for a confirmation to a summarization. (A closed-ended question that encourages the dialogue to continue)	"So [to summarize] what Dr. [S] was saying, so if the topic was interesting - like riveting - do you guys feel more inclined to participate? "So to clarify, you want more concepts introduced each time that you meet?" "So you want to get more knowledge as a group? It's not you don't want to do it individually? You want to have it done here, correct?"	***Elicitive***

Table 3.4.7 Continued from Table 3.4.6, a step by step guide on how to code each mediator's turn and examples

4	**Is the mediator's statement…**		
4a	An acknowledgement/positive reinforcement/confirmation/agreement	"*Okay*. So then yes, that was good." "*I see*."	***Elicitive***
4b	A summary/rephrase/repeat	"So *what I'm hearing* for the solution is that we need to be asking more questions, asking why if we don't understand but in conjunction with making sure that it's because we're being attentive and just simply let's say if we just don't understand, to be more clear." "Basically *what you're saying is* [that] you have dialogue anyway?"	***Elicitive***
4c	Prompts for further elaboration/clarification	"Can *you rephrase* that in one sentence, I don't understand."	***Elicitive***
4d	The mediator's own perspective/opinion/ideas/reason	"So *I bring* that up because with the directions, some were not clear. So, *I think* that's a really great time to ask, can you repeat the directions, can you make it more clear, not because you're not listening, and then asking why. Does that make sense?" (ended with a close-ended question) "That's what *I've been doing* with the previous stage. Remember that I have said, "No comment, then okay, cogen has to stay." Because I thought 30 minutes minimum."	***Directive***
4e	Providing an evaluation	"*I agree* with her too." "So [having cogen once a week] is a solution that cannot commence [or can we] implement it…" "This is [worth] thinking about…*I think* that's a good idea too. I agree with you but most likely*, I think* we will have to implement a minimum."	***Directive***
4f	A direction for students or the mediator themselves	"There's no right or wrong*. I need* you guys *to participate*, okay." "*Raise your hand* if you agree with that."	***Directive***
4g	Providing the issue or solution	"*I have* an issue. We did receive a complaint about loudness in the lab. [S]o when we go just respect. We can obviously do three in your group and your RA, but just don't give them any reason to say anything. [S]o just [work] in your lab, do your PPE, and just don't do anything that will cause attention to yourselves."	***Directive***
4h	Answers a question from the group	Scientist: "Do we need to raise our hand?" Mediator: "Yes"	***Directive***
4i	Off-Topic		***Directive***

Table 3.4.8 Examples of mediators using more than one style of mediation in a turn

If the turn is more than one mediation style		
Begins *Directive* and ends *Elicitive*. (Ending Sentence)	"I think I agree with you because we are here almost from 1:00 to 4:00. (*Directive*) I mean, we need something. (*Directive*) But do you think-- what? (*Elicitive*)" "But all inclusive when we're speaking. Does everybody agree with that solution? I want to see your hands. (*Directive*) Next issue, that you guys had. Anybody? (*Elicitive*)"	***Elicitive***
Begins *Elicitive* and ends *Directive*		***Directive***
Having two or more examples		
The mediator provides an evaluation and a direction	"I'm not trying to convince you. These are the questions (an evaluation) -- yeah, go ahead. (a direction)"	***Directive***
The mediator asks open-ended and closed-ended questions	"So then my question goes back to you, *do you care* what the other students in your class in your arts and your sciences (closed-ended questions), *why would you* not do the same as since this is a group learning (open-ended question), like you wouldn't at least try (closed-ended questions)? Like you're telling me that this is how you learn and this is the best way for you (closed-ended question)?"	***Directive***
The mediator provides their reason /perspective and the solution to an issue	"That was my fault, John...I was supposed to give you the PowerPoints, but I had to email it to you guys but that didn't happen on my end, but from now on you will be given what you're going to have prior to your internship, so that's a solution that they already planned that. I dropped the ball."	***Directive***

In the following Figure 3.3, a condensed graphical flow chart version is presented of the above tables. This figure visually demonstrates the flow of decisions on how to code each turn by a mediator. Not shown in the following flow chart are the directions on how to code for multiple mediations styles.

3.4.3 Defining Cogen Sets of Issues and Solutions

Another challenge in the data analysis was defining how to section a lengthy cogen session into subsets to be examined closer. One goal is to discuss a shared issue in cogen and agree upon a solution to the issue. Thus, by focusing on an issue and solution pair, a cogen set was defined. An issue is defined as the discussion and agreement on a problem that the group is having. When agreed upon, the discussion moves into solving the issue and agreement on the

solution. For example, cogen can open a discussion about student engagement during a session, and the group will agree upon the issue. The mediator will move the discussion into solving this issue.

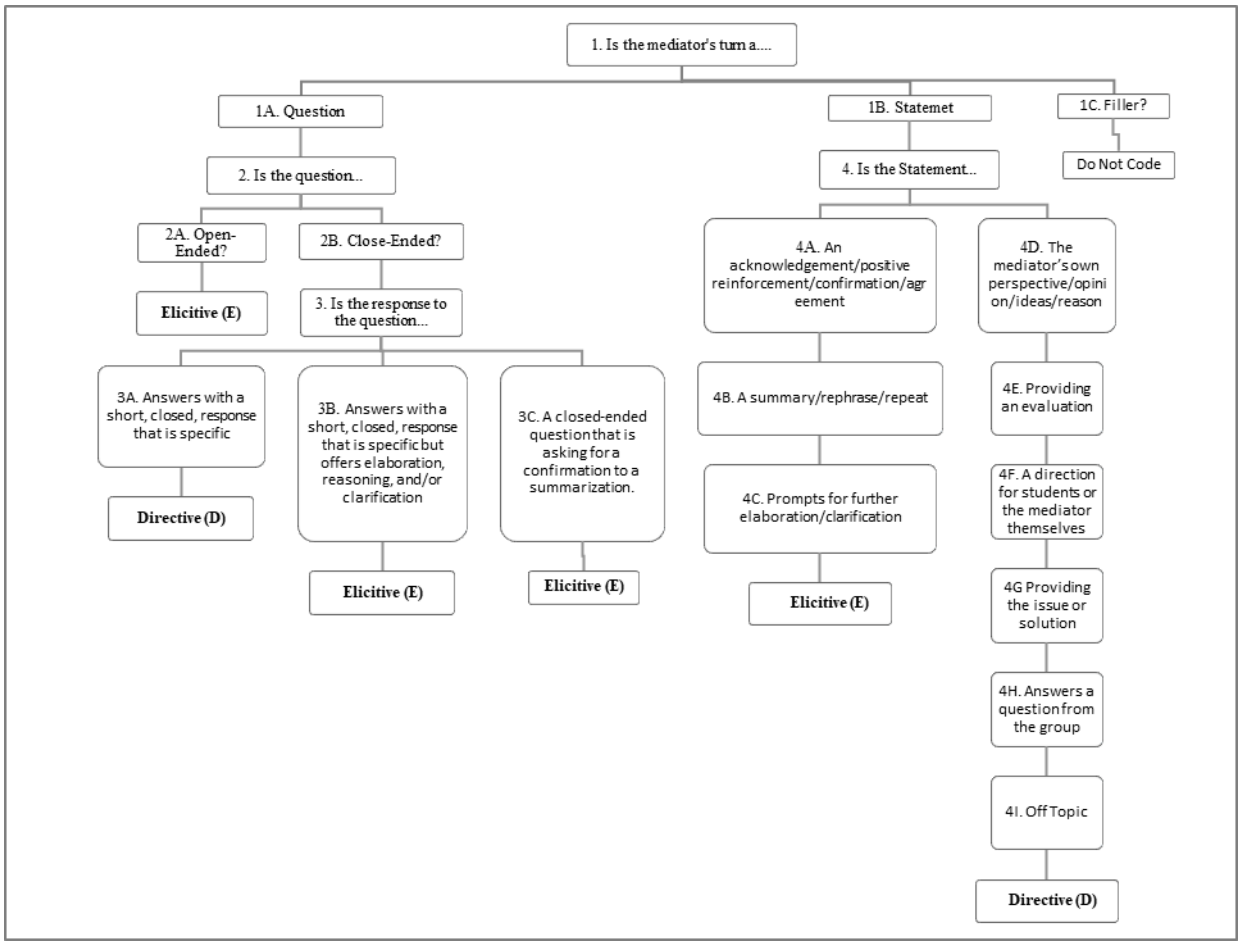


Figure 3.2. Mediator mediation of cogen analysis flow chart to define *Elicitive* (E) and *Directive* (D).

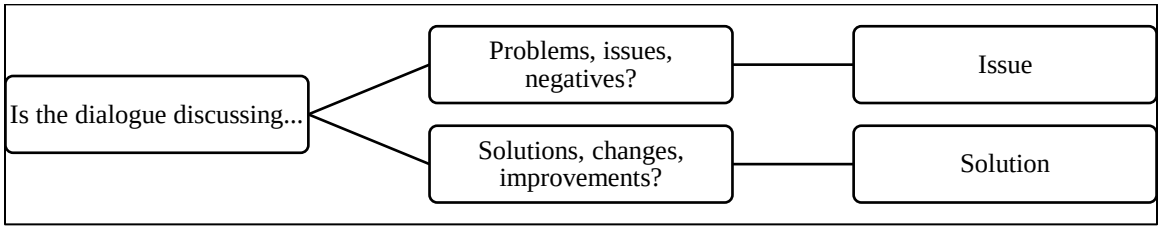


Figure 3.3. Mediator mediation of cogen analysis flow chart to define issues and solutions to a topic set.

3.5 Credibility of Data Analysis

Due to this study's nature and qualitative data, the data's credibility is a concern and considered throughout the study. The data's credibility was established using several methods from the *fourth-generation evaluation (*Guba & Lincoln, 1989).

3.5.1 Prolonged Engagement & Observation Bias

As with any research, *Observation Bias* may occur due to insufficient data leading to a biased interpretation of the data (Lincoln & Guba, 1985). *Prolonged Engagement* is a constructivist approach to research that recognizes that the more extended observations take place, the more context they can understand from participants' perspectives, which enables a credible and holistic account to form (Creswell & Miller, 2000). Though *prolonged engagement* has no set time limit, typically, it is four months or longer, meaning that this study satisfies this criterion by observing participants in the laboratory and throughout cogen for over six months (Creswell & Miller, 2000).

Another recommended method of reducing observation bias is through *Persistent observation,* which identifies and focuses on characteristics, traits, and attributes that are the most relevant to the investigation (Lincoln & Guba, 1985); this is done by separating relevant from irrelevant observations in the data (Onwuegbuzi & Leech, 2007). "Whereas prolonged engagement provides scope, persistent observation provides depth" (Onwuegbuzi & Leech, 2007, p.239). To follow *persistent observation* (Lincoln & Guba, 1985), recordings of interactions between participants through video recordings and field notes have been conducted. Also, only relevant portions of the cogen dialogue are taken into account. The study focuses on issues and solutions discussed during cogen, and any dialogue deemed inconsequential, such as personal conversations, are ignored.

3.5.2 Inter-Rater Agreement

An inter-rater agreement is used to determine the reliability of the coding scheme and data to establish the consistency for transferability within the coding scheme for outside context. The chosen interrater agreement (IRA) method is the kappa statistic, which measures IRA for categorical qualitative items (Landis & Koch, 1977). Kappa is thought to be a more substantial measure than a simple percent agreement because kappa takes chance agreement into account. Kappa has also been a successful measurement tool for assessing and refining evaluation methodologies (Nichols, Wisner, & Cripe, 2010). This then assesses the clarity of instructions for the method of evaluation, rather than a novice coder's accuracy (Carletta, 1996). To ensure the most comprehensive cogen evaluation method, the kappa value will lend valuable feedback on the reliability of the coding method. The sample size for a credible IRA has been reported to be approximately 10% of the full sample, hardly ever more than 300 units, which was used to determine the sample size for this IRA (Neuendorf, 2002). This study contains around 3000 samples; each sample is considered a single turn or utterance by the mediator. This entails that a sample size of 300 is a sufficient size for a credible IRA. The strength of IRA is determined by the example provided by Landis and Koch (1977): Kappa Statistic Strength of Agreement < 0.00 Poor; 0.00-0.20 Slight; 0.21-0.40 Fair; 0.41-0.60 moderate; 0.61-0.80 Substantial; 0.81-1.00 Almost Perfect. The IRA method includes training a second coder on the coding scheme, allowing them to code based on the first discussion, and using Kappa to determine the agreement between the original coder and second coder. Several rounds are conducted to determine areas of disagreement and how to improve on the coding scheme. Throughout five rounds, agreement improved by 0.25 from 0.29 or fair agreement and ended with a result of 0.56 or moderate agreement (Table 3.5.2). Some of the discussions on improving the schema involved making the problem continuum and whether this addressed each turn the mediator took or the overall

problem being discussed. It was agreed based on the research done by Riskin (1996, 2003a, 2003b) that the problem continuum would be defined as the overall topic of the issue. The second improvement on the interrater agreement's schema was on how to define closed-ended questions that received an open-ended response. The initial schema defining this terminology was deemed too vague for others to understand, and an improved definition was created.

The equations used to determine IRA are as follows (Viera & Garrett, 2005):

$K=(P_o - P_e)/(1 - P_e)$

P_o= Percent Agreement / Sample size

$P_e= [(N_1/S)*(M_1/S)]+[(N_2/S)*(M_2/S)]$

Figure 3.4 Kappa Equation used to determine interrater agreement (Viera & Garret, 2005)

Symbols Used for Kappa Calculations	
K = Kappa	S= Sample Size
P_o= Observed Agreement	P_e = Expected Agreement
a, d = agreement between Raters	b, c = disagreement between Raters
N_1=Total "Yes" from Rater 1 (a+c)	N_2=Total "No" from Rater 1 (b+d)
M_1=Total "Yes" from Rater 2 (a+b)	M_2=Total "No" from Rater 2 (c+d)

Figure 3.5 Symbols used in Kappa calculation for Figure 3.5.

Table 3.5.1 Interrater Agreement matrix used for Kappa.

Interrater Agreement (Kappa)

		Rater 1		
Rater 2	Results	Yes	No	Total
	Yes	a	b	M_1
	No	c	d	M_2
	Total	N_1	N_2	S

Table 3.5.2 Results of inter-rater agreement from Kappa formula for five rounds. `

Round	*Kappa*	*Sample Size*	*Agreement*
1	0.29	285	Fair Agreement
2	0.31	285	Fair Agreement
3	0.28	348	Fair Agreement
4	0.49	348	Moderate Agreement
5	0.55	295	Moderate Agreeement

3.5.3 Transferability

Another credibility method employed is *transferability*, or the ability to generalize the context of the data to other contexts outside of the research question *(*Guba & Lincoln, 1989). This is done by providing a thorough and descriptive methodology of analyzing the data, which may be transferable to a *Broad*er context. This relates to the IRA's process and the development of a consistent coding scheme for the data. Ensuring that the coding scheme is easily understood and followed by someone other than the original researcher lends itself toward *transferability* (Guba & Lincoln, 1989) and using this information outside of this study in a *Broad*er context.

Additionally, the methods and descriptions are enhanced with real examples from the data, which lends transparency to the analysis. To establish *dependability* (Guba & Lincoln, 1989), the methodology is demonstrated in flow charts that show how the data is analyzed consistently. With no conflict of interest in the research, abundant data can be viewed objectively by the researcher.

Chapter 4: Findings

The study aims to analyze mediation styles used by mediators to facilitate cogenerative dialogues between high school students and scientists. In this chapter, five categories of analysis address the four mediators who participated in the internship. Each section displays graphic representations and discusses the results for each mediator and a comparison of results. For each section, examples from post-internship student and mediator interviews and reflections that align with the reported findings are included to support these studies' findings when applicable.

4.1 Choosing the Data

There was a total of 21 days that cogen was implemented throughout the internship; these days are divided into three phases, with seven cogen sessions in each phase to determine the most impactful data from this study. Based on post-interview conversations with students and mediators, the data from the middle phase, the beginning of May through the end of June of the internship, was the chosen focus analyzed. This section of data consists of cogen sessions conducted in the last few meetings where the groups met every other Saturday and the beginning of summer, where the group met for cogen twice a week.

Data at the beginning of the internship was not included in the final analysis. This decision was decided based on reports from students and mediators. Students and mediators expressed the challenges and frustrations during the initial part of the internship, where much time was taken to establish cogen expectations, routines, and relationships. For example, when asked about the beginning of the internship, M1 explained how they "do a lot [at] the very beginning just to make sure [students] know [their] background" with M4 also confirming this statement by explaining that "At the beginning [the students] were not as confident enough to

talk [and] ask questions because they were lost." Students also agreed that progress improved as the internship continued, stating that "Progress always improved…I remember communication at the beginning was horrible" (2L1AT). Thus, due to the nature of new experiences and developing skills for the internship and cogen, the first seven cogens' data was not included in the final analysis.

Similarly, data from the last seven cogens was also not included in the final analysis. This decision was also based on reports from students and mediators during post-internship interviews. Students were on location during the end of the internship, working on their final projects for five days of the week for nearly the whole day and meeting for cogen on 2 of those days. Students felt that cogen was not as beneficial, a waste of time, and preferred to focus their energy on completing their projects. Mediators also found it challenging to engage in conversations, and discussions became superficial. Conversations with students supported the idea that toward the end of the internship, cogen was not as constructive, "towards the end, I feel like...no one would talk about the issues…at times I guess it was frustrating because a lot of people didn't want to be there" (2l2ed). Other students expressed their frustration that the time taken for cogen could be used on their final project "like a waste of time - especially at the end, we were trying to get results and…the time in the Lab was precious to us—" (2l2ap). With students becoming more focused on their project and unable to find actionable problems for discussion, it was decided that the data from the last seven cogens would not be included in the final analysis in this study.

The middle phase of the data from this internship's cogen session would focus on this analysis. These days included the last days that students met every other Saturday while still attending their regular school days during the week and the first few cogens that they

participated in during the summer portion of their internship. Students and mediators reported that they felt most successful with cogen during this phase of the internship. This may be due to having focused on establishing internship routines, building intentional relationships, and fostering cogen expectations during the beginning of the internship, along with the novelty of the start of summer. When asked about a challenging cogen, M4 stated that "I think it was good at the beginning. 'Cause it was every other Saturday…But then summer started, and it was monotonous…I think at the very last nobody liked cogen." One student mentioned that cogen felt the most productive when "coming towards the end of the internship, I feel like it was good that while we were still in school" and "then the first week, first two weeks…of summer" (2l4AD). Thus, the data from the middle seven cogen sessions became the focus of this study's analysis.

4.2 Identifying the Exemplar

During this analysis of this cohort for the *Work with a Scientist Program*, Lab 1 was identified as the most effective of the four mediators and an exemplar mediator within this study. Identifying this mediator was based on anecdotal statements and observations from the participants within this study. Based on interviews and journal entries from students, scientists, and the mediators themselves, Lab 1 was identified as the exemplar for this study.

Students from Lab 2 (2L2SE) reported that their mediator would put words in their mouths, breaking one of the main rules of cogen; everyone's perspectives are valued (Emdin, 2011). Additionally, students from the same Lab also described how cogen became boring, and they did not know what to talk about even though the mediator maintained the conversation, meaning that the conversation did not hold value for students. Other students also referred to their frustration with their mediator not helping keep the conversation on track, "he tried to stay

on track, but everybody had like their side conversation, and they were going in the other direction than what he meant" (2L2ED). In Lab 3, students conveyed how their mediator insisted on working toward a solution on an issue that was out of the students' control, leading to frustration. (2L3BB). To confirm their student's feelings, Lab 3's mediator also discussed how they noticed that their students felt that cogen was unnecessary and that cogen just became a requirement of the internship. During a post-interview asking about how mediators, students, and scientists defined cogen, Lab 4's mediator stated that she felt students defined cogen as a place to show their emotion and complain. This aligns with the cogen rules that all have equal turns and different perspectives, and opinions are valued (Edwin, 2011). However, during the same question, she also explained that many of her students were not concerned about showing their emotions. "I just do not think [the students] were concerned about showing their emotions. Some of them were. But some of them were not as interested in showing their emotions."

To contrast the reports from the other three Labs, students from Lab 1 described in their post-interview data that they felt accomplished at identifying, solving the problem, and applying solutions, one of the critical foundations of a successful cogen (Emdin, 2011). In the student's own words, they were able to "solve all the [problems] and apply the solutions…as soon as possible…which is a growing experience for everybody" (2L1YC). When talking about strategies used in mediation, Lab 1's mediator conveyed that she felt that the essential part of cogen was always to bring the conversation back to the topic at hand. In her words, "Always try to bring it back. Always try to redirect." Based on these testimonies from both the mediators and the students participating in the program, Lab 1 was identified as having the most effective

mediation during the four mediators' cogen. Thus, in the analysis, how Lab 1's approach to mediation is compared to the other Labs will be highlighted.

4.3 Data

In total, the data from 29 cogen sessions were critically analyzed. In Table 4.3.1, the entirety of the data is presented from each mediator, the time intervals, whether the topic was *Broad* or *narrow*, whether the entire cogen session was *Elicitive* or *Directive*, and a closer look at whether the issue and solution discussions were *Elicitive* or *Directive*. For the column labeled "Cogen," this is an identifier for the cogen session number; a letter after the number signifies that there were multiple significant issue discussions brought forward during this session. In the "Time" columns, a breakdown of the amount of time spent during issue discussions, solution discussions, and the total time for that issue and discussion pair is displayed. For the "Topic" column, a "B" or an "N" represents "*Broad*" or "*Narrow*," respectively. Under the "*Elicitive* vs. *Directive*" columns, you can find the number of turns taken by the mediator that was identified to be either *Elicitive* or *Directive* and the total number of turns. This is like the "Issue" and "Solution" columns; however, a more detailed look of the data is displayed.

Table 4.3.1 Data collected from this analysis.

		Time (min:sec)			*Topic*	*Elicitive vs Directive*				*Issue*			*Solution*	
	Cogen	*Issue*	*Solution*	*Total Time*	*Broad vs Narrow*	*Elicitive*	*Directive*	*Total Turns*	*Elicitive*	*Directive*	*Total Turns*	*Elicitive*	*Directive*	*Total Turns*
Lab 1	8a	*13:40*	1:21	15:01	B	11	7	18	11	5	16	0	2	2
	11a	*3:38*	0:49	4:27	B	2	3	5	2	2	4	0	1	1
	11b	*0:41*	1:28	2:09	B	4	4	8	1	0	1	3	4	7
	14a	*6:03*	4:40	10:43	B	21	15	46	7	16	23	14	9	23
	14b	*9:28*	5:48	15:16	B	9	46	55	5	31	36	4	15	19
Lab 2	8a	4:32	2:00	6:32	B	27	15	42	17	10	27	10	5	15
	10a	17:25	2:08	19:33	B	22	26	48	15	16	31	7	10	17
	10c	3:28	1:04	4:32	N	8	10	18	4	5	9	4	5	9
	11a	1:21	1:54	3:15	B	5	15	20	0	8	8	5	7	12
	12a	1:56	6:19	8:15	N	10	36	46	2	12	14	8	24	32
	14a	4:18	3:09	7:27	N	5	24	29	0	15	15	5	9	14
Lab 3	9	0:30	1:42	2:12	B	5	5	10	0	1	1	5	4	9
	10a	7:55	3:07	11:02	N	3	21	24	1	9	10	2	12	14
	10b	1:51	1:53	3:44	B	6	4	10	3	3	6	3	1	4
	11	4:13	2:01	6:14	B	10	10	20	6	4	10	4	6	10
	12	1:05	2:32	3:37	N	5	2	7	2	0	2	3	2	5
Lab 4	8a	3:11	1:06	4:17	N	3	4	7	3	2	5	0	2	2
	8b	3:23	5:45	9:08	B	1	7	8	1	2	3	0	5	5
	8c	3:00	2:28	5:28	N	4	4	8	4	0	4	0	4	4
	9b	4:46	0:13	4:59	N	3	5	8	3	1	4	0	4	4
	9c	1:33	1:13	2:46	N	1	6	7	0	4	4	1	2	3
	10a	3:36	2:07	5:43	N	3	4	7	1	3	4	2	1	3
	10b	4:18	1:21	5:39	N	3	7	10	3	2	5	0	5	5
	12a	3:16	0:19	3:35	N	1	5	6	1	3	4	0	2	2
	12b	2:20	3:48	6:08	N	7	13	20	1	4	5	6	9	15
	13a	2:54	8:50	11:44	N	4	8	12	3	3	6	1	5	6
	13b	1:07	2:15	3:22	N	1	5	6	1	2	3	0	3	3
	14a	9:40	0:23	10:03	N	1	8	8	0	5	5	0	3	3
	14b	4:03	3:50	7:53	N	3	10	13	1	5	6	2	5	7

4.4 Average percent of Issue and Solution Sets that were spent on *Broad* and Narrow topics per mediator

This portion of the analysis addresses whether mediators in cogen, on average, focus more on *Broad* or *Narrow* topics for problems. *Narrow* refers to problems impacting one to three individuals, while *Broad* refers to problems that impact the whole Lab or the whole *Work With a*

Scientist program. For this analysis, the entire discussion topic during an issue and solution set was evaluated for whether it was *Broad* or *Narrow*. This was done by dividing the total number of *Broad* or *Narrow* issue/solution sets by the total number of sets for each internship phase (Figure 4.4.1).

$$\frac{\text{Total Number of Issue and Solution Sets that were } \textbf{Broad or Narrow} \text{ during phase}}{\text{Total Number of Issue and Solution Sets During Phase}} \times 100 = \text{Average percent of time spent on } \textbf{Broad or Narrow} \text{ Topics during each Phase per Mediator}$$

Figure 4.4.1 Formula used to calculate the average percent of Issue and Solution sets that were spent on *Broad* or Narrow topics during cogen

Table 4.4.1 The four Lab's overall data on Broad vs. Narrow topics discussed during issue and solution sets within cogen.

Lab	***Lab 1***		***Lab 2***		***Lab 3***		***Lab 4***	
Broad	5	100%	3	50%	2	60%	1	8%
Narrow	0	0%	3	50%	3	40%	12	92%

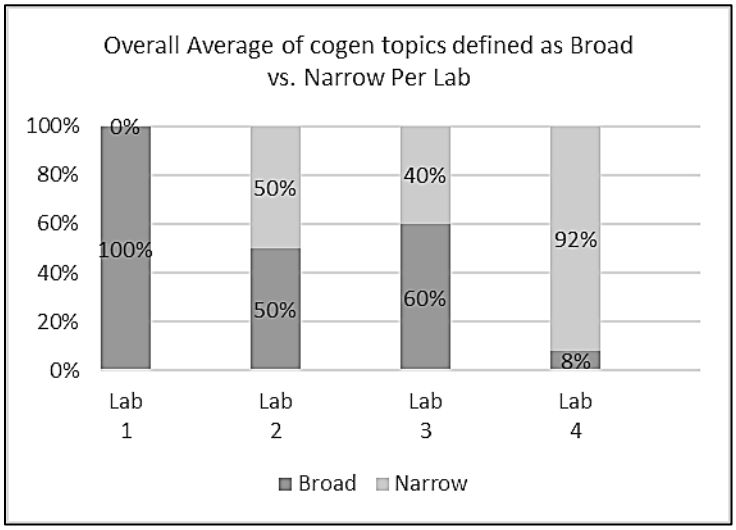


Figure 4.4.2 The four Lab's overall comparison of the average percentage of cogen topics for issues defined as *Broad* versus *Narrow*

Figure 4.4.2 shows the four mediators' average percentage of Broad or Narrow topics for problems. This figure represents the average percentage of *Broad* or *Narrow* issue topics of discussion brought forward during cogen used by mediators. When looking at the overall averages for cogen topics for issues when defined as *Broad* and Narrow (Figure 4.4.2), it is quickly identified that in Lab 1, the discussion topics are entirely *Broad*. This meant that of all the topics of discussion, the most influenced stakeholders were the entire Lab or a problem that affected the whole program.

The remaining three Labs showed a range of results. Results for Lab 2 demonstrate equal amounts of *Broad* and Narrow topics. This reveals that half of the discussion topics impacted the whole group or whole program and the other half were issues that impacted one to three students. Data for Lab 3 reveal similarities with Lab 2 but tend to be *Broad*er with an average of 60% and 40% for *Narrow*. This shows that though the focus was placed on problems related to the whole Lab, problems that affected individuals were also discussed, but with less frequency.

On the other hand, Lab 4 was nearly entirely *Narrow* in their issue topics, with an average of 92% of topics being *Narrow* and 8% of topics being *Broad*. This is nearly the opposite in comparison to Lab 1, whose topics were entirely *Broad*. This shows that an emphasis on issues that impacted individuals or small groups of students was the focus of discussion.

4.5 Comparison of Time spent during cogen on issues and solutions per mediator

In this next analysis, the average time spent during discussions on issues and solution sets that discussed one topic during cogen is compared between the four Labs. Total time was determined by when the mediator initially asked about any issues that the group may have, and it ended on the final actionable decision made by the group. In this total time amount, only one issue is being discussed. When determining the time intervals for issues and solutions, when the

mediator actively switches between receiving consensus from the group on the core issue being discussed and discussing the solution is brought forward is how this data is determined. For example, all mediators specifically ask, “Do we agree that this is an issue?” when they receive majority confirmation from the group. The mediators then ask along the lines of “What ideas do we have for a solution?” All the cogen sessions follow this main framework of establishing an issue, then discussing the solution. These time intervals can be seen in Table 4.4.1. To find the average percent, the time spent during issues or solutions was divided by the total time spent on one topic of discussion (Figure 4.5.1).

$$\frac{\text{Time spent during Issue or Solution}}{\text{Total Time Spent during Issue and Solution}} \times 100 = \text{Average Percent of Time Spent During Issue or Solution Discussion}$$

Figure 4.5.1 Formula used to calculate the average percent of time spent during issue or solution discussions by each mediator in cogen.

Figure 4.5.2 shows that the average percent of time spent during issues and solutions is compared with each mediator. When analyzing the average length of time spent on the discussion of issues compared to solutions, it reveals that Lab 1 spent the most time on issues compared to the other mediators. The findings show that Lab 1 focused more time on discussions of issues, 65%, as compared to the solution, 35%. Lab 2 spent 60% of the time on issues and 40% of the time on solutions. Both Labs spend more of their time discussing the issue than the solution. However, with Labs 3 and 4, this is not the case. Lab 3 spent 48% of the time on a single topic on discussing the issues and 52% of the time discussing solutions. This is supported by evidence from student journals. “This week in Cogen, I found that it was not as productive... We spent the entire session discussing the different solutions to getting to the program late…our mediator was trying to force us to try and make a solution” (2L3BB). In this quote, a student

from Lab 3 is referencing the time spent on discussing solutions. Lab 4 spent very little time on issues, 11%, and most of the time discussing solutions, 61%.

Table 4.4.1 The four Lab's overall data of time spent during cogen discussing issues and solutions

	Issue (m:s)	***Solution (m:s)***	***Total Time (m:s)***	***% Issue***	***% Solution***
Lab 1	13:40	1:21	15:01	91%	9%
	3:38	0:49	4:27	82%	18%
	0:41	1:28	2:09	32%	68%
	6:03	4:40	10:43	56%	44%
	9:28	5:48	15:16	62%	38%
			Average %	*65%*	*35%*
Lab 2	4:32	2:00	6:32	69%	31%
	17:25	2:08	19:33	89%	11%
	3:28	1:04	4:32	76%	24%
	1:21	1:54	3:15	42%	58%
	1:56	6:19	8:15	23%	77%
	4:18	3:09	7:27	58%	42%
			Average %	*60%*	*40%*
Lab 3	0:30	1:42	2:12	23%	77%
	7:55	3:07	11:02	72%	28%
	1:51	1:53	3:44	50%	50%
	4:13	2:01	6:14	68%	32%
	1:05	2:32	3:37	30%	70%
			Average %	*48%*	*52%*
Lab 4	3:11	1:06	4:17	74%	26%
	3:23	5:45	9:08	37%	63%
	3:00	2:28	5:28	55%	45%
	4:46	0:13	4:59	96%	4%
	1:33	1:13	2:46	56%	44%
	3:36	2:07	5:43	63%	37%
	4:18	1:21	5:39	76%	24%
	3:16	0:19	3:35	91%	9%
	2:20	3:48	6:08	38%	62%
	2:54	8:50	11:44	25%	75%
	1:07	2:15	3:22	33%	67%
	9:40	0:23	10:03	96%	4%
	4:03	3:50	7:53	51%	49%
			Average %	*61%*	*39%*

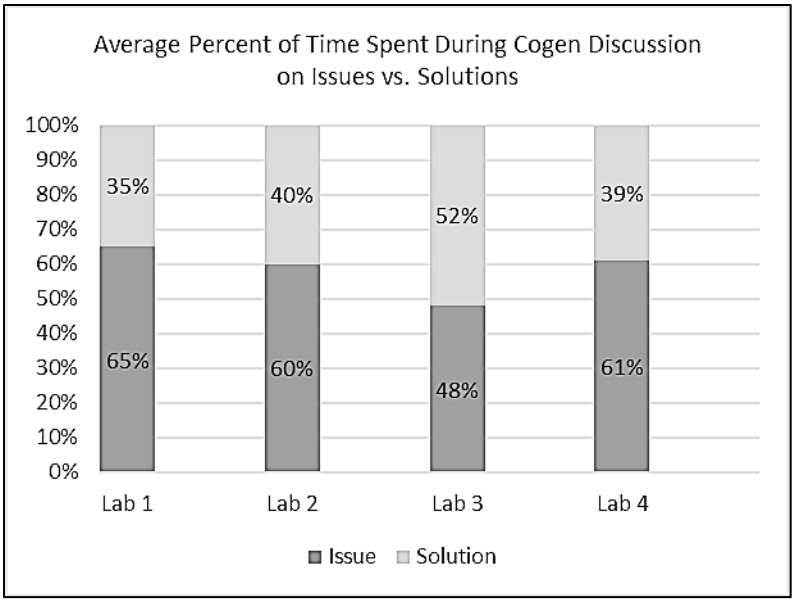


Figure 4.5.2. The four Lab's overall comparison of the average percentage of time spent during cogen discussing issues and solutions.

4.6 Average percent of *Elicitive* and *Directive* Mediation During Cogen per mediator

In this part of the analysis, the mediation style that cogen mediators used on average during issues and solution discussions is addressed. *Elicitive* refers to the mediator encouraging participants' perspectives, helping to communicate and understand each other and asking open ended-questions, while *Directive* refers to the mediator guiding participants toward some or all outcomes and asking closed-ended questions.

This analysis is calculated by dividing the total number of turns by the mediator that was identified as *Elicitive* or *Directive* in an Issue and Solution set by the total number of turns taken by the mediator for that set, then dividing by the total number of issues and solution sets for that phase of the internship (Figure 4.6.1)

In this analysis of *Elicitive* and *Directive* mediation used for discussion topics, the data reveals that Lab 1 had an overall average of 55% *Directive* mediation and 45% *Elicitive* mediation (Figure 4.6.2). The mediator for Lab 1 discusses moving between *Directive* mediation into *Elicitive* mediation by beginning with posing closed-ended questions to the students to guide

them in reflection on their internship "[On watching a video of students during their internship] You don't say anything, and [then] you say, 'Well, tell me your observations. Which one did you like? Which one didn't you like?' And you put them in that field to observe it. And then also…'What could've been better?'" (M1).

$$\frac{\left(\frac{\text{Total Turns during an Issue and Solution Set defined at } \textbf{Elicitive or Directive}}{\text{Total Turns by Mediator During an Issue and Solution}}\right)}{\text{Total Issue and Soltuion Sets per Phase}} \times 100 = \text{Average Percent of } \textbf{Elicitive or Directive} \text{ Mediation used by each Mediator during Each Phase of the internship}$$

Figure 4.6.1. Formula used to caclualte the average percent of *Elicitive* or *Directive* mediation used by each mediator during one issue solution set of cogen.

In comparison, the data from Lab 2 reveals that their use of *Directive* mediation is 61% and *Elicitive* mediation is 31%. The Lab that used the most *Elicitive* mediation was Lab 3 with an average of 49% of the discussion time for a topic. Their *Directive* mediation is 51%. Data from Lab 4 shows that their mediator's average use of *Directive* mediation is 76% compared to *Elicitive* mediation, 24%.

Overall, the average mediation style when looking at a single topic of mediation in cogen was *Directive* for each Lab. However, because cogen is about evaluating learning structures by discussing both issues and produce actionable solutions, the mediation style for both issue and solution discussions should be analyzed as one whole unit and as two separate units (Boss & Linder, 2016; Im & Martin, 2015; Shady, 2015; Tobin & Roth, 2005; Siry, 2011; Wassel et al., 2013). Thus, in the next two analyses, the most frequently used mediation style during issues and solutions is more closely evaluated.

Table 4.6.1 The four Lab's overall data for *Elicitive* or *Directive* mediation used by each mediator during cogen

	Elicitive	***Directive***	***Total Turns***	***% Elicitive***	***% Directive***
Lab 1	11	7	18	61%	39%
	2	3	5	40%	60%
	4	4	8	50%	50%
	21	15	36	58%	42%
	9	46	55	16%	84%
			Average %	*45%*	*55%*
Lab 2	27	15	42	64%	36%
	22	26	48	46%	54%
	8	10	18	44%	56%
	5	15	20	25%	75%
	10	36	46	22%	78%
	5	24	29	17%	83%
			Average %	*31%*	*69%*
Lab 3	5	5	10	50%	50%
	3	21	24	13%	88%
	6	4	10	60%	40%
	10	10	20	50%	50%
	5	2	7	71%	29%
			Average %	*49%*	*51%*
Lab 4	3	4	7	43%	57%
	1	7	8	13%	88%
	4	4	8	50%	50%
	3	5	8	38%	63%
	1	6	7	14%	86%
	3	4	7	43%	57%
	3	7	10	30%	70%
	1	5	6	17%	83%
	7	13	20	35%	65%
	4	8	12	33%	67%
	1	5	6	17%	83%
	1	8	9	11%	89%
	3	10	13	23%	77%
			Average %	*24%*	*76%*

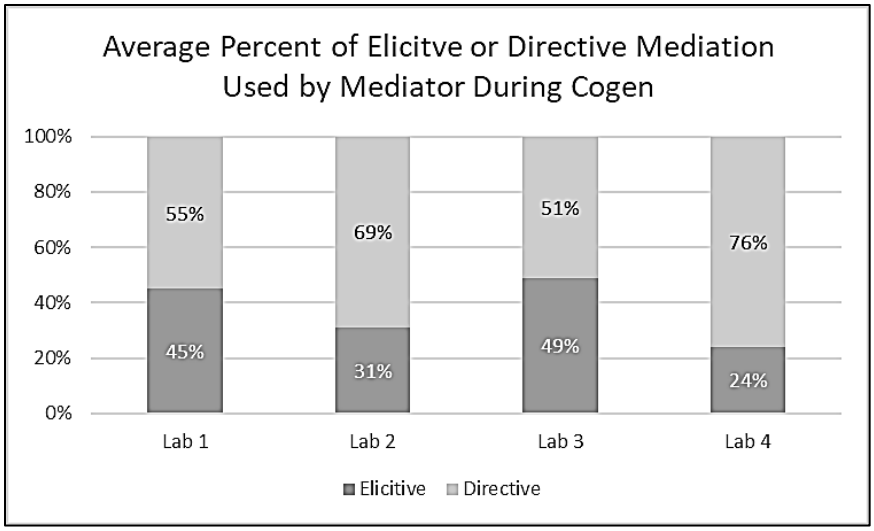


Figure 4.6.2 The four Lab's overall comparison of the average percentage of *Elicitive* versus *Directive* mediation identified during each issue/solution set of cogen

4.7 Average Percent of *Elicitive* and *Directive* Mediation During Issue Discussions per Mediator

This sub-section of the analysis addresses the previous question of what style of mediation that cogen mediators are using on average but focuses on the cogen discussion issue. Like the calcuations done in the previous section on the mediation style used, the total number of *Elicitive* or *Directive* turns identified for each mediator was divided by the total number of turns (Figure 4.7.1). However, the focus was only on the issue discussion within a single topic of an issue/solution set. This allows for a more detailed analysis of mediation style within the issue discussion or cogen.

$$\frac{\left(\dfrac{\text{Total Turns Identified as } \textbf{Elicitive or Directive} \text{ during Issue Discussions}}{\text{Total Turns by Mediator During Issue Discussions}}\right)}{\text{Total Issue and Soltuion Sets per Phase}} \times 100 = \text{Average Percent of } \textbf{Elicitive or Directive} \text{ Mediation used by each Mediator during Issue Discussions for each Phase of Internship}$$

Figure 4.7.1. The formula used to calculate the average percent of *Elicitive* or *Directive* meditaion used by each mediator during Issue discussions of cogen.

The results of this analysis demonstrate that each of the four Labs used a wide range of *Elicitive* and *Directive* mediation (Figure 4.7.2). Lab 1 used the most amount of *Elicitive* mediation, 53%, during their discussion on an issue, and 47% of *Directive* mediation. The Lab that used the second most *Elicitive* mediation during their discussion of an issue was Lab 3 at 44% and 56% *Directive* mediation. Lab 4 demonstrates that, on average, they used *Elicitive* mediation 38% of the time taken to discuss issues and 62% of the time using *Directive* mediation. Lastly, Lab 2 revealed the least amount of *Elicitive* mediation practice during their discussion of issues, 28%, and exhibits more *Directive* mediation, 72%.

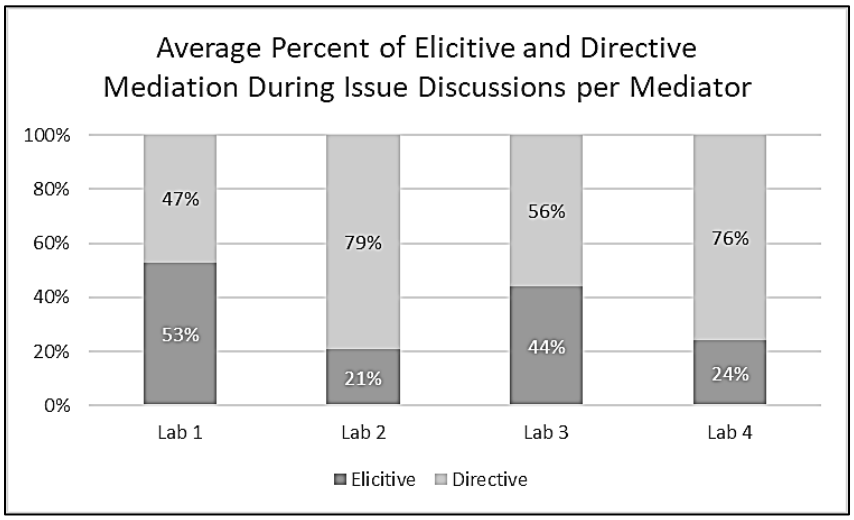


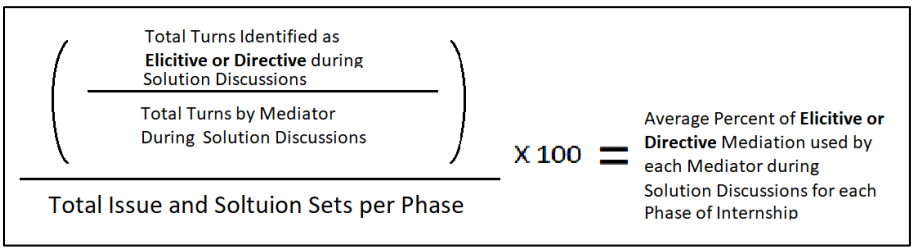
Figure 4.7.1 The four Lab's overall comparison of the average percentage of *Elicitive* versus *Directive* mediation during issue discussion in cogen

Table 4.7.1 The four Lab's overall data for *Elicitive* and *Directive* mediation during Issue discussions during cogen.

	Elicitive	***Directive***	***Total Turns***	***% Elicitive***	***% Directive***
Lab 1	11	5	16	69%	31%
	2	2	4	50%	50%
	1	0	1	100%	0%
	7	16	23	30%	70%
	5	31	36	14%	86%
			Average %	*53%*	*47%*
Lab 2	17	10	27	63%	37%
	15	16	31	48%	52%
	4	5	9	44%	56%
	0	8	8	0%	100%
	2	12	14	14%	86%
	0	15	15	0%	100%
			Average %	*21%*	*79%*
Lab 3	0	1	1	0%	100%
	1	9	10	10%	90%
	3	3	6	50%	50%
	6	4	10	60%	40%
	2	0	2	100%	0%
			Average %	*44%*	*56%*
Lab 4	3	2	5	60%	40%
	1	2	3	33%	67%
	4	0	4	100%	0%
	3	1	4	75%	25%
	0	4	4	0%	100%
	1	3	4	25%	75%
	3	2	5	60%	40%
	1	3	4	25%	75%
	1	4	5	20%	80%
	3	3	6	50%	50%
	1	2	3	33%	67%
	0	5	5	0%	100%
	1	5	6	17%	83%
			Average %	*24%*	*76%*

4.8 Average Percent of *Elicitive* and *Directive* Mediation During Solution Discussions per Mediator

This sub-section of the analysis addresses what style of mediation that cogen mediators are using on average within the solution discussion of cogen. As with the calculations for the previous section, the total number of *Elicitive* or *Directive* turns identified for each mediator is divided by the total number of turns. However, the focus was only on the solution discussion within an issue/solution set. This allows for a more specific mediation style analysis within the solution discussion of cogen (Figure 4.8.1).



4.8.1. Formula used to calculate the average percent of *Elicitive* or *Directive* mediation used by each mediator during cogen solution discussions.

When studying the data for mediation style within the solution portion of an issue topic, it is shown that each Lab was unique in how they guided the discussions between students and scientists (Figure 4.8.2). Lab 1 reveals that their average use of *Elicitive* mediation is 25%, and Directive mediation is 75%, meaning that they used more close-ended questioning during the solution discussion than during the issue discussed during the solution discussion.

This may be because Lab 1 may have embedded solution discussions within the initial discussion of students' issues. Conversely, it is noted that many of the ideas for solutions to an issue were provided by the mediator, scientist, or research assistant. For example, one topic of discussion brought forward by a research assistant was Lab safety of students. The entire group had a consensus that this was an issue. However, the solution was brought forward by the

research assistant who used *Directive* dialogue that gave specific directions to the students on Lab safety expectations

Table 4.8.1 The four Lab's overall data for *Elicitive* and *Directive* mediation during Solutions discussions during cogen.

	Elicitive	***Directive***	***Total Turns***	***% Elicitive***	***% Directive***
Lab 1	0	*2*	2	0%	100%
	0	1	1	0%	100%
	3	4	7	43%	57%
	14	9	23	61%	39%
	4	15	19	21%	79%
			Average %	*25%*	*75%*
Lab 2	10	5	15	67%	33%
	7	10	17	41%	59%
	4	5	9	44%	56%
	5	7	12	42%	58%
	8	24	32	25%	75%
	5	9	14	36%	64%
			Average %	*38%*	*62%*
Lab 3	5	4	9	56%	44%
	2	12	14	14%	86%
	3	1	4	75%	25%
	4	6	10	40%	60%
	3	2	5	60%	40%
			Average %	*49%*	*51%*
Lab 4	0	2	2	0%	100%
	0	5	5	0%	100%
	0	4	4	0%	100%
	0	4	4	0%	100%
	1	2	3	33%	67%
	2	1	3	67%	33%
	0	5	5	0%	100%
	0	2	2	0%	100%
	6	9	15	40%	60%
	1	5	6	17%	83%
	0	3	3	0%	100%
	0	3	3	0%	100%
	2	5	7	29%	71%
			Average %	*17%*	*83%*

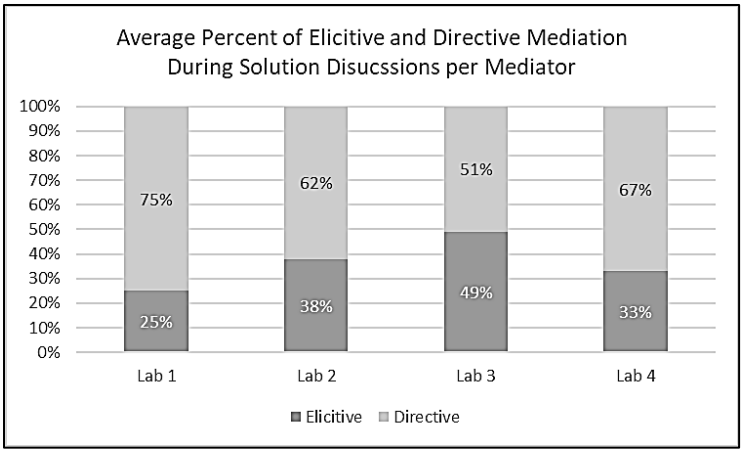


Figure 4.8.2 The four Lab's overall comparison of the average percentage of *Elicitive* versus *Directive* mediation during solution discussion in cogen

Lab 2 showed that the average use of *Elicitive* mediation for solution discussion is 42%, while *Directive* mediation is 58%. On average, Lab 3 used the most *Elicitive* mediation for their solution discussion at 49% and *Directive* mediation at 51%. Lastly, Lab 4 used the least amount of *Elicitive* mediation on average to discuss solutions with their group at only 14% and *Directive* mediation at 86%, meaning that most of the discussion during solutions were closed-ended questions and responses.

Chapter 5: Conclusions and Discussion

Throughout this thesis, Riskin's framework grid (2003a) was used to analyze the various styles of mediation methods used by mediators to understand how cogen between students and scientists was conducted within the Work With a Scientist Program. A framework based on Riskin's Mediation Grid (2003a) was developed for this study to identify whether a mediator was using *Elicitive* or *Directive* mediation and whether their topic of discussion was *Broad* or *Narrow*. In this study, mediators facilitated cogenerative dialogues between high-school students and scientists during an internship to foster an environment of equality and develop actionable solutions to problems affecting the program.

Throughout this analysis, it was found that the exemplar mediator spent more time discussing issues and was identified as using *Elicitive Broad* strategies during the issue portion of cogen then using *Directive Broad* strategies in the solution portion of cogen. This demonstrated that the framework developed for this analysis could be used to examine mediators' methods used during cogen. These results and their implications will be discussed in depth within this chapter's major sections.

5.1 *Broad* and *Narrow*

Compared to the other Labs, Lab 1 demonstrated that all their discussion topics were *Broad,* as shown in section 4.3. Lab 1 was 100% *Broad* while the other Labs were significantly less: Lab 2 – 50%, Lab 3 – 40%, Lab 4 – 8% (Figure 4.4.2). When comparing the four Labs, Lab 1 was identified as the exemplar mediator for cogen, as discussed in section 4.2. Thus, it was identified that one of the key takeaways from this study was how mediators whose topics of discussion were *Broad*er in the topic were more effective for cogen. Having a *Broad* topic of discussion entails focusing on issues affecting an entire Lab or program rather than a person.

Some of the *Broad* issues discussed in Lab 1 included time-management, communication, and safety while working in the Lab. These topics had typical outcomes that improved the quality of the internship for all participants. One of the crucial aspects of cogen is having shared experiences between stakeholders and reflecting on the teaching-learning activities that focus on all participants (Tobin & Roth, 2005). Thus, it shows that these instances in which a Lab discussed a *Broad* problem that affected the whole group and the agreed-upon solution by the Lab improved the internship quality for all.

In addition to this, Riskin also states that mediators who focus on *Narrow* problems could potentially deprive participants of opportunities to understand underlying roots to problems as compared to mediators encouraging a *Broad*er focus (Riskin, 2003). For example, Lab 4's topics of discussion were nearly entirely *Narrow* in topic and focused on problems that only affected one or two students. The solutions to the problems may have improved the internship for these few students but did not reach beyond these individuals. This shows that mediators who focus their group's discussion on *Broad* problems enhance discussions by encouraging stakeholders' perspectives. Cogenerative dialogues strive to identify problems and create actionable solutions that foster an environment where individuals understand that the whole group's success includes their own. Thus, it may be implied that a mediator who focuses on more *Broad* topics is a more effective mediator for cogen in an internship setting between high-school students and scientists.

5.2 Time

When analyzing the amount of time that mediators spent on their issue discussion, it is shown that there was a slight difference between Lab 1 and the other three Labs. In Lab 1, the amount of time spent talking about issues was 65% of the time, while the other Labs were: Lab 2 – 60%, Lab 3 – 48%, and Lab 4 – 61% (Figure 4.5.2). In cogenerative dialogues, stakeholders

are tasked with discussing issues affecting the group and developing an actionable solution. In this study, it was essential to understand how mediators focused on these essential aspects of cogen during their hour-long session. This was further analyzed by comparing how much time was spent in issue discussions compared to solution discussions.

When discussing issues, it can be said that there may be more embedded discussion on possible solutions within that time, when the discussions move into talking about actionable solutions to the problem it has already been addressed in the last part of the conversation. This shows that Lab 1 may have been more effective in building a more robust dialogue within the issues portion of cogenerative dialogue and enabled cogen to be more productive for students and scientists. This is especially important when considering that part of the cogenerative dialogue is working together to decide on an issue affecting a whole group.

Though Lab 1 spent the most time discussing issues, 65%, this was only slightly different from Lab 4, 61%, and Lab 2, 60%. This may show that though Lab 1 was considered the exemplar for this study, spending more time discussing issues may be a natural part of dialogues demonstrated in cogen. However, because three of the four mediators spent more time discussing problems, it can be said that this is a significant result that could help guide more effective cogens in the future. Mediators who maintain a more extended discussion on the issue at hand before moving the conversation to solutions to the problem may be more useful for cogenerative dialogues.

5.3 *Elicitive* Mediation During Issue Discussion

Within this study, it was shown that the most effective mediation by Lab 1 was more *Elicitive* in nature, 53% (Figure 4.7.2) during their discussions on issues as compared to the other Labs: Lab 2 – 21%, Lab 3 – 44%, Lab 4 - 24%. *Elicitive* mediation encourages participants to

lead in the discussion and develop their solutions, while *Directive* mediation takes a more direct approach in guiding stakeholders in discussions (Riskin, 2003a). Having identified Lab 1 as the exemplar for this study, it was concluded that mediators who demonstrate a more *Elicitive* approach in their discussions on issues are more effective mediators for cogenerative dialogue.

Evidence that mediators are more effective when using an *Elicitive* approach in cogen is supported by a recent study on cogenerative dialogues with teachers and students in a high-school setting; researchers reviewed a particular incident where cogen failed (Henderson, Oakley, & King, 2019). After having behavior problems in class, the teacher required a group of students to attend cogen with the teacher acting as the mediator and leading the discussion by gaining insight from students on the behavior of an individual not present. The researchers believed that part of the reason for the failed cogen was due to the teacher, who acted as mediator, making the cogen a requirement for these students and took away the power from students and placed it on the teacher, breaking an essential rule to cogen that resulted in a shift in power dynamics. However, in the review of the dialogue presented in the study, the teacher's mediation approach to discussing the issue with the students was identified as *Directive* when using the framework created for this study. Quotes directly from this study demonstrated questions such as: "How do you find Cody? Like is he disturbing you, does it affect your learning?" which are considered closed-ended questions and "I actually find it hard to teach sometimes with Cody, well when he calls out all the time…It's well not fair on everyone else is it?" can be interpreted as the mediator providing their perspective of the situation (Henderson, Oakley, & King, 2019, p. 102). Though a *Directive* approach may not have been the sole reason for a failed cogen, it shows that using such an approach may not have been the best strategy to use in this circumstance.

Though *Directive* mediation in cogen has its time and place, in this situation, it may have contributed to the failed cogen and why students felt uncomfortable with responding. When there is an unbalanced power dynamic within a group conducting cogen, using *Elicitive* mediation to empower student's voice becomes an important tool to balance those powers. Cogen is designed to allow traditional hierarchical structures to be broken by allowing power to be shared by participants (Dondi et al. 2016; Im & Martin, 2015; Shady, 2015; Siry, 2011; Siry & Martin, 2014; Stith & Roth, 2010; Tobin, 2006; Tobin, 2014; Wassel et al., 2013). *Elicitive* mediation is a key part of cogen, which helps "Elicit the parties' perspectives…and then tries to honor or accommodate them." (Riskin, 2003a, p. 30) and helps balance power. Thus, Henderson, Oakley, and King (2019) study how *Directive* mediation can hinder the dialogues of cogen.

In a counter article to Riskin's Mediation Grid (1996), Kovach and Love (1998) suggest that mediators' goals should be first to further resolve the problem by eliciting the parties' discussion. Though Kovach and Love (1998) were opposed to the mediation grid orientations developed by Riskin (1996), their thoughts on the idea demonstrate that mediators should be *Elicitive* in nature when facilitating the discussion of the problems affecting the parties involved. This supports this study's findings that mediators who are *Elicitive* during the discussion of an issue may have effective cogens.

In this study, Lab 1's mediator demonstrated a stronger *Elicitive* approach when discussing cogen issues compared to the other Labs. Thus, it can be implied that in cogenerative dialogue, a more effective mediator uses an *Elicitive* approach when discussing issues.

5.4 *Directive* Mediation During Solution Discussions

The results of this analysis showed that Lab 1 demonstrated more *Directive* mediation during the solution discussion of mediation, 75%, as compared to the other Labs: Lab 2-62%,

Lab 3-51%, Lab 4-67% (Figure 4.8.2). In *Directive* mediation the mediator is pushing the parties toward an outcome while *Elicitive* mediation draws responses from participants.

Based on the idea that in cogen, one of the goals is to produce an actionable solution, it can be implied that *Directive* mediation during this stage of cogen may be the most advantageous method of guiding participants. During the initial discussion on identifying the problem, the mediator is drawing responses and engaging participants to understand their thoughts and feelings. At this stage, a general direction for the solution may already be embedded within the discussion. Lab 1's mediator described how she worked to understand the students truly and listened to what they had to share, giving them an equal voice during their discussion during her post-internship interview. Thus, finding an actionable solution would occur organically; the mediator may only need d*irective* mediation to have the most useful session. The data does demonstrate a trend among the mediators of favoring *Directive* mediation during this phase of discussion, with Lab 1 demonstrating the most frequent use.

However, as noticed in the analysis, many of the turns coded during this phase were typically asking for consensus on solutions among the participants. This may have influenced the data in that the same question was asked several times until a consensus was reached. On the other hand, these types of close-ended questions that are yes or no answers are examples of the definition of *Directive* mediation.

Thus, it may be concluded that a more effective mediator for cogenerative dialogue demonstrates more *Directive* mediation strategies in their discussions on solutions when they have used *Elicitive* strategies and listened in-depth to student voices in earlier discussions on issues.

5.5 Summary

Based on the results, this study has shown that a significant mediator for cogenerative dialogues between high-school students and scientists:

- Focuses the topics for discussion on issues that are *Broad*.
- Spends more time during their discussions on the actual issue than on the solution.
- Uses more *Elicitive* mediation strategies during the discussion of issues.
- And uses more *Directive* mediation strategies during the discussion of solutions.

5.6 Limitations and Implications

One limitation of this study was the training, experience, and background of the mediators themselves. Though Lab 1 was identified as the exemplar of this study, she was the oldest of the four mediators, was majoring in speech pathology, and was a native English speaker. Other mediators, who were younger, majoring in science fields and were identified as English being a secondary language, stated on occasion during post-internship interviews that it was a struggle to guide mediation. Though in many cases, multilingual cogenerative dialogue can be a benefit to engaging all students, like in the study by Im and Martin (2015) with English and Korean students, this may have affected the outcome of student engagement. Thus, further research of a larger pool of mediators with a broader range of backgrounds, experience, and languages is recommended.

In addition, another limitation is the nature of the study itself in relying on identifying mediation strategies through a qualitative approach. In a literature review on qualitative research, it was stated that case studies, such as in this study, offer a unique opportunity to investigate complex situations using various variables (Queiros, Faria, Almeida, 2017). However, Queiros, Faria, and Almeida (2017) also warn that generalized conclusions may be difficult to establish when small numbers are considered. In this research study, qualitative analysis is the chosen

approach, and the research is based on a limited number of mediators and data. It is identified as a limitation to the research. It is recommended that further research with more mediators from multiple years of the internship would benefit this study's findings.

These findings have implications for use in the classroom by educators. I have begun to incorporate the mediator grid into my own practice and reflection on teaching in my own experience. Understanding the differences between the type of topic, *Broad* or *Narrow*, and the method of engaging my students, *Elicitive* or *Directive*, has helped to scaffold dialogues within my classroom. Educators within their classrooms may use this grid system to self-reflect on their methods for facilitating student discourse, identifying their current mediation method, and guiding them toward more student voice within their classroom by moving from *Directive* to *Elicitive* discussions. This type of deliberate reflection allows an educator to understand when they are using *Directive* or *Elicitive* mediation. Understanding the style of mediation being used to engage students in dialogue lets educators decide on the best direction to take a discussion. If students are not engaging and sharing their thoughts and ideas, *Directive* mediation on *Narrow* topics may be a starting point for building the trust for students to begin to share. Once students are more comfortable responding to these *Directive* and *Narrow* topics, an educator may begin to ask more *Elicitive Narrow* questions and build the practice toward a class that is willing to share their thoughts and ideas. Future research using this framework developed in this study from Riskin's Mediation Grid (2003a) within a classroom to review its effect on student engagement and educator-driven discourse is recommended.

Other implications of these findings demonstrate how this framework developed from Riskin's Grid (2003a) may allow educators to analyze their discourse not only with students but with their professional learning communities (PLC). PLCs are based on reflective dialogue in

which educators discuss their teaching and learning techniques to identify issues and solutions (Hord, 1997). However, in many circumstances, staff meetings can be less than effective due to the difficulty in reaching a shared goal among individuals and the occasional perceived power differences in those running a meeting and the participants (Klein, 2005). These meetings may become more effective if a mediator who can guide discussion and flow between different mediation methods to meet the stakeholders' needs is present. Having a person mediate the discussion with an understanding of the modified mediation grid within this study may help make these interactions more effective by establishing equal power among participants and ensuring more time is spent on discussing the issue using *Elicitive* mediation. Continued research with the framework from this study on whether it would improve staff meetings' effectiveness in professional learning communities is recommended. Future research using this framework developed in this study from Riskin's Mediation Grid (2003a) within a classroom to review its effect on student engagement and educator-driven discourse is recommended.

5.7 Future Research

Ideas for future research from this analysis include exploring how mediators with different professional backgrounds would direct the conversations between high school students and scientists during cogenerative dialogues. For example, a comparison of professionally practicing mediators from a variety of fields including education, family conflict management, and commercial industry using the framework in a student-scientist internship setting.

Another area of potential future research would be identifying the differences of mediation methods used when first introducing cogen to an internship cohort, the methods used in the middle of an internship, and the methods used at the end of the internship. This could identify best practices for mediation of cogen and how to best structure the dialogues to have the

most benefit for participants. To further drive this area of research, mediators of cogen may be followed over several years to determine if mediation practices have improved over time and with practice.

And lastly, further formalizing of the theoretical framework developed for this analysis to be used in a variety of situations is an area of potential future research. This framework may benefit fields such as restorative justice which also includes mediators to bridge the conversation between parties.

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Curriculum Vita

Chelsea Elizabeth Lucas obtained her Bachelor of Science in Geology from UTEP in 2013. She taught children and adults with special needs how to ride horses in adaptive riding lessons for ten years and left the field in 2015. After receiving her degree in geology, she interned for the Geological Society of America as an Interpretation Specialist at Chaco Culture National Historic Park. This internship helped to guide her toward a path in Education.

Chelsea began the Alternative Teacher Licensure program through UTEP. After completing the program, she continued with graduate classes to finish her Master of Arts in Education. During this time, she participated in NASA's Minority University Research and Education Program (MUREP) in 2018. Chelsea became a curriculum designer and program manager for Pick and Learn, a story-based STEM program through UTEP and funded by NASA in 2018-2020.

While finishing her graduate program, Chelsea began teaching Middle School Science in 2020. Currently, she is a participant in the Achieve-Excellence Rising New Mexico Program.