EVALUATING GROUP-WORK: IMPLICATIONS ON SCIENCE DISCOURSE AND PEER INTERDEPENDENT RELATIONSHIPS

by

Tashi Dhondup Langton

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Tashi Dhondup Langton

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Michi Thacker, M.A., Member of the Faculty

ABSTRACT

Group-work in science provides students with a platform to work collaboratively with their peers. This learning environment can give students many rich opportunities to engage in science talk and develop pro-social behaviors. This action research project examined the implementation of group-worthy tasks in a Biology classroom to see how science discourse and peer-to-peer interdependent development were impacted. A series of six group-worthy tasks were administered over five weeks. Data collected for analysis included: pre- and post-questionnaires, three focus student interviews, research journal, video-recordings, and whole-class and individual observations. Data was analyzed and triangulated and three findings appeared: 1) students engaged in science talk more frequently, 2) although the majority of group members engaged in group-work, this group-work was not always equitable, and 3) science discourse and peer-to-peer interdependent development seemed to be influenced by the amount of time a group had worked together. Implications for teaching practices include setting up many opportunities for students to engage in discussion, designing assessments for group-worthy tasks that require individual and group accountability, and setting and maintaining expectations for participation in group-work. Recommendations for future research include grouping assignments, practices to increase individual and group accountability, and setting norms and expectations for group-work.

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CHAPTER 1—INTRODUCTION AND LITERATURE REVIEW

National and State Level High Stakes Testing in Science

> "No single test score can be considered a definitive measure of a student's knowledge, and an educational decision that will have a major impact on a test taker should not be made solely or automatically on the basis of a single test score" (National Research Council, 1999).

The current trend of standardized testing serving as a stand-alone requirement for grade-promotion, tracking decisions, and high school graduation has been criticized by the National Research Council (NRC) of the National Academy of Sciences. Francis Eberle, the former executive director of the National Science Teachers Association, stated: "For 9 years, elementary school principals have been telling teachers not to teach science because it's not a part of No Child Left Behind…Now those students are in high school, and we've seen the consequences of that policy" (Mervis, 2011). Eberle was making reference to the 2009 scores on the National Assessment of Educational Progress (NAEP), which measured student achievement in reading, math, and science at the 4th, 8th, and 12th grades. The science assessment found that 40% of high school seniors perform below the basic level in science and only 1% at the advanced level (Mervis, 2011).

In response to the increasing demands requiring students to meet standards, the Washington State Legislature passed House Bill 1410 in May, 2011 which altered the science assessment graduation requirements. Now in high school, students in Washington are required to pass the biology End of Course Exam (EOC), which is based on the State's K-12 Science Learning Standards. Since implementation, "Students in the classes of 2015 and beyond are required to meet the state standard in science on the biology EOC to be eligible to graduate. All 10th graders who have not previously passed the biology

EOC must take the state's science exam as required by No Child Left Behind, whether or not they have completed a biology course" (Office of Superintendent of Public Instruction (OSPI), 2014). This is the reality that students and teachers at the focus school for my research are faced with.

Demographics and Science Instruction in Focus School

Karma High School[1], at the time of this study, was situated in an average size city in western Washington State. The school was classified as urban and had a student body of 1,100 that was racially, ethnically, linguistically, culturally, and socioeconomically diverse. The school offered multiple science classes including biology. Students were required to take one year of biology in their 10th grade year and then take the biology EOC. The school's most recent biology EOC scores were similar to the national science scores of 2009. The relatively low passing scores (48% for 2011-2012, 43% for 2012-2013, and 50% for 2013-2014) were a cause for concern (OSPI, 2014).

Increasingly, teachers have felt the pressures of testing. With concepts being added to the curriculum, many science teachers say they are pressed to cover too many concepts in a school year. This leads to the banking concept of instruction, where teacher-centered lecture and individual student worksheet methods are the primary means of delivering content instruction to their students (Freire, 2000). This may be a result of time constraints, or because lecturing was the method by which many teachers learned science when they were in high school and when they were studying to become science teachers (Llewellyn, 2013).

[1] All names in this study are pseudonyms to protect the identities of the research site and participants.

If one of the central goals of science education is to promote scientific reasoning, then teacher-centered instruction, by not fully exposing students to true scientific discourse, does not meet that goal (National Research Council, 2000). According to the National Science Teachers Association (2004), science should be focused on developing student-interdependent relationships during inquiry-learning through group-work. The attention paid to individual worksheets does little to promote a community of interdependent peers in the science classroom. In addition, students can become easily disengaged during instruction due to the material having no relevance to the students' lived reality (Boutte et al., 2010).

These concerns led me to choose to investigate what effect planning and implementing group-work in the science classroom would have on peer-to-peer interdependent development and student engagement with the material. I was very interested in this collaborative aspect of scientific discourse, particularly in students' co-construction of knowledge, because I believe this teaches students what it means to do science, while also making it more accessible to all learners. Here I explore what research and literature says regarding teacher versus student-centered instruction, diverse learners, culturally-responsive teaching, and group-worthy tasks in the science classroom to structure my research question.

Teacher-Centered Instruction in the Science Classroom

Zull (2002) talks about teachers not giving enough credit to students for what they are capable of. This is echoed by Milner (2010) when he discusses teachers' deficit mindsets in regard to their students, particularly students of color. The idea of potential is highlighted in the child developmental psychology work of Dewey (1916), Piaget (1954), and Vygotsky (1999) who argue that children have immense capabilities and are actively involved in discovery (Miller, 2011). When this discovery is hindered by a teacher-centered classroom or by a heavy emphasis placed on standardized testing, results show that students became disinterested and disengaged from critical thinking (Alonso et al., 2009; Cuban, 2013). No Child Left Behind (NCLB) may have encouraged teachers to focus on disengaging, coverage teaching, where habituation occurs in what is known as the "Twin Sins of Traditional Design" (Wiggins & McTighe, 2005; Zull, 2002). These twin sins are outlined as follows: "a) aimlessly going through organized material within a prescribed time for the sake of 'coverage', and b) to engage students in activities that do not result in learning because students were not asked to consider the *meaning* of the activity" (Wiggins & McTighe, 2005, p. 16). This "banking" concept dehumanizes students by minimizing their creative power, limiting their sense of agency, and mirroring an oppressive society (Freire, 2000).

A study conducted by Vedder-Weiss & Fortus (2011) showed a decline in students' motivation to learn science from 5th to 8th grade in Israeli traditional schools. The researchers define traditional schools as those where teachers "have little autonomy in choosing what to teach and which materials to use, and teaching is becoming more and more aimed at succeeding on standardized tests" (Vedder-Weiss & Fortus, 2011, p. 203). The decline in motivation was apparent in students' motivation for school science learning (personal mastery goals and classroom engagement) as well as in their continuing motivation (engagement in and rejection of extra-curricular science related activities). In contrast, the researchers did not find any decline in students' science motivation among students in democratic schools. The researchers defined democratic schools as those that: “share some common characteristics: 1) they are managed by shared decision-making among the students and staff, 2) students can choose which subjects to learn and in general, what to do with their time, 3) there are usually no required classes, and 4) the staff supports students by offering facilitation according to students’ interest and needs” (Vedder-Weiss & Fortus, 2011, p. 202). The researchers stated that as students became less and less engaged in science learning at school, they also became less engaged in science-related activities out of school. This disengagement led to student resentment towards science-related activities (Boutte et al., 2010; Vedder-Weiss & Fortus, 2011).

In order to critique inquiry-based learning and teaching, Kirschner et al. (2006) investigated unguided and minimally-guided instructional approaches. They stated that although these approaches were very popular and gained fame post-Sputnik, based on what we know about human cognition, inquiry teaching was ineffective. In fact, they stated that if instruction is without heavy teacher involvement, it will be ineffective because human cognitive structures are organized and therefore our learning style should also be. The researchers claim that even with students that had significant prior knowledge, strong guidance given while learning was equally as effective as unguided approaches in science. The study also stated that unguided instruction could have negative results and students were more likely to acquire misconceptions, disorganized knowledge, or incomplete knowledge (Kirschner et al, 2006).

Although Kirschner et al. (2006) raised interesting arguments against inquiry teaching, researchers Hmelo-Silver et al. (2007) provided a series of counterarguments in their critique. The first argument is that Kirschner et al. (2006) defined constructivist, discovery, problem-based, experiential, and inquiry-based teaching/learning under the category of minimally guided instruction. Hmelo-Silver et al. (2007) believed that problem-based learning and inquiry-based learning are not minimally guided instructional approaches and that they both provide guidance and scaffolding that is extensive in order to assist student learning. Researchers' Kirschner et al. (2006) claimed that problem-based learning and inquiry-based learning are ineffective is contrary to empirical evidence, which actually supports the efficacy of problem-based learning and inquiry-based learning. There was evidence, discussed in the following section, that these approaches can foster deep and meaningful learning as well as significant gains in student achievement, engagement, and attitude (Britner & Pajares, 2006; Lord, 1997). In addition to content standard learning, Hmelo-Silver et al. (2007) believed that problem-based learning and inquiry-based learning can also promote softer skills, such as collaborative work, which are not measured by achievement tests. These softer skills speak to the real work of scientists. The researchers concluded by saying that there is a need to provide balance between direct instruction and problem-based learning and inquiry-based learning (Hmelo-Silver et al., 2007).

Inquiry-Learning and Student-Centered Instruction in the Science Classroom

According to the National Science Education Standards (NSES) "scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work" (Anderson, 2002, p. 23). Due to many researchers defining inquiry differently, I wanted to define it in the context of inquiry-learning (Anderson, 2002). Inquiry-learning refers to an active learning process that engages students, "encompasses a range of activities" (Anderson, 2002, p.

33), and “includes multiple stages such as ‘oral and written discourse’” (Anderson, 2002, p. 36). By teaching students there are multiple ways to approach a scientific phenomenon, and by respecting these approaches and showing they have value, students’ inquiry process can be developed. This in turn promotes critical thinking skills that are valuable in science and in other disciplines. This student-centered approach aligns itself well with discovery learning (Miller, 2011).

Discovery learning can be defined as encompassing an instructional model with strategies that focus on active, hands-on learning opportunities for students. Bicknell-Holmes and Hoffman (2000) described the three main attributes of discovery learning as: “1) exploring and problem solving to create, integrate, and generalize knowledge, 2) student driven, interest-based activities in which the student determines the sequence and frequency, and 3) activities to encourage integration of new knowledge into the learner’s existing knowledge base” (p. 314). When put into practice, students rely on their prior knowledge and questioning among peers, whereas the teacher serves as a facilitator, providing students ways to access resources. This is empowering for the students as they assume more responsibility in their own learning process (Zull, 2008). Students gain confidence in themselves and their abilities, do not have the fear response in their amygdala hindering their thinking, and can therefore approach learning with intrinsic motivation, putting their ideas into actions thus completing the learning cycle (Dec, 1995; Zull, 2008). The learning cycle as defined by Zull (2008) includes four stages where a learner: 1) experiences concrete experiences, 2) reflects on the observation and make connections, 3) generates abstract hypotheses, 4) and then actively tests the hypotheses, which leads into new concrete experiences and therefore a new learning cycle ensues.

A classroom that includes dialogue promotes inquiry, sharing of developed theories, thinking, and extension. Science curriculum is equivalent to a foreign language and promoting the use of scientific language must include the use of dialogue (Groves, 1995). This transformative process of teaching requires adapting to a more authentic approach to teaching science to a classroom of diverse learners. In a study by Wells & Arauz (2006), researchers concluded that an inquiry orientation to curriculum did make dialogue more likely to occur. There was large emphasis placed on collaborative learning and communication. In this collaborative learning environment, students are encouraged to build off of one another's contributions. This promotion of co-constructed knowledge ties in well with the learning theorists and authors who value social, inquiry-based, and collaborative learning. Similarly, social interactions can be used as vehicles to respond to students' questions and answers. These interactions aid in the cultivation of a culture where questions and comments can be turned into learning opportunities (Lau et al., 2009).

Research performed in secondary and college level science classes showed that a hands-on, inquiry-based approach improves student achievement, their attitude towards science, and self-efficacy, giving more support for the implementation of inquiry-based teaching practice in the science domain (Britner & Pajares, 2006; Lord, 1997). In addition, Blackburn-Morrison (2005) found evidence in the science classroom that linked an inquiry approach to student motivation, students' retention of knowledge, and positive experiences for lower achieving students.

It is important to note that there is a difference between authentic and simple inquiry tasks. Researchers Chinn & Maholtra (2002) defined authentic scientific inquiry as a method that follows three standards: 1) explain array of evidence, 2) decide what evidence to use, and 3) critique the explanation and procedure. They defined simple inquiry tasks as textbook tasks that oversimplified the three standards in authentic scientific inquiry. In their study they found that simple inquiry tasks might not only fail to help students learn to reason scientifically, but might also foster a non-scientific epistemology in which scientific reasoning is viewed as simple, certain, algorithmic, and focused at a surface level of observation. They found that many students appeared to hold such beliefs about science, and the researchers' analysis suggested that simple inquiry tasks used in schools might have been partly responsible for promoting these beliefs. The researchers found that textbook curricula were dominated by oversimplified tasks that did not come close to authentic scientific inquiry (Chinn & Malhotra, 2002).

Providing an inquiry-based approach that emphasizes equal opportunity, respects diversity, and encourages student participation can create a positive and safe classroom culture (Friere, 1998; Freeman & Freeman, 2009; Zwiers, 2008). This large step towards equitable teaching and learning can generate an interdependent community where students see themselves and their peers as resources where cooperation and contingent communication, which is "characterized by a collaborative give-and-take of signals between the members of the pair", can occur (Friere, 1998; Noddings, 2013; Siegel & Hartzell, 2003). When this occurs, students learn to respect individual diversity and became proponents of "free and equitable exchanges across groups and individuals expressing different viewpoints" (Noddings, 2013, p. 12). Respect for diversity within the classroom allows students to read the world, before the word (Friere, 1998), feel a sense of relatedness and unity and create a safe space that leads to opportunities for meaningful dialogue to occur.

Diverse Learners in the Science Classroom

With the onset of new standards (Next Generation Science Standards), teachers need to be mindful of how academic language is used in the classroom and what types of discourse are used among students. Teachers who are familiar with the content material risk having blinders. These blinders can cause teachers to be oblivious to their students not learning or being unfamiliar with the academic discourse vocabulary and content-specific vocabulary in the taught curriculum (Zwiers, 2008). This becomes particularly problematic for English Language Learners (ELLs), who may have fluent conversational skills, but lack the appropriate academic language to excel in summative assessments, such as essays and tests, thus putting them at a disadvantage (Freeman & Freeman, 2009). In addition, non-student friendly language and summative assessments put students who do not use academic discourse outside the classroom at an unfair disadvantage (Delpit, 1988; Freeman & Freeman, 2009; Gee, 2001; Zwiers, 2008). Furthermore, students can feel threatened by this vocabulary triggering an amygdala fear response and preventing them from participating in or avoiding particular subjects (Cuban, 2013; Zull, 2002).

With an increase in diverse learners in the classroom, teachers must consider all learners and how they would best benefit from implementing teaching practices that promote equity within their classroom. When implementing an inquiry-based approach in the classroom, diverse learners show a high level of interest in using concrete activities for learning science. These activities de-emphasize vocabulary acquisition, which frequently causes difficulty for students with disabilities, and contributes to an increase in content knowledge as well as favorable attitudes toward the content (Bodzin et al., 2007). In addition, inquiry makes science more accessible to students who are still learning the English language. Inquiry allows all students to see relevance in what they are studying. The longer they learn in this environment, there is a direct correlation between improved achievement scores in science and improved linguistic proficiency in English (Amaral et al., 2002; Lee, 2005).

Teachers must encourage and facilitate ELL students' investigations to help them develop their sense of inquiry. Scientific inquiry practices can be challenging for ELL students, especially those who are not encouraged at home, have less experience in school science, have been "disenfranchised by the social institutions of science," and cannot relate science to their real-world, or their future. ELLs benefit from hands-on, inquiry-based instruction (Amaral et al., 2002). Hands-on activities help ELLs construct shared meanings, improve their understanding of science, and increase engagement in inquiry. Increased engagement in inquiry helps ELLs develop their English vocabulary and grammar. Hands-on activities lessen linguistic burdens and barriers, and do not require as much verbal instruction, which can be challenging for ELLs (Lee, 2005).

Collaborative group-work provides students with structured opportunities that help develop their understanding of the content and construct-shared meanings (Freeman & Freeman, 2009). Inquiry-based instruction in the science classroom can help ELLs with communicating through written, gestural, oral, and graphic formats (Amaral et al., 2002). This supports the use of inquiry, because it benefits all learners in the classroom and makes science more accessible to students who are still learning the English language.

Culturally Relevant Teaching in the Science Classroom

The negative effects of teacher-centered classrooms and testing are only further exasperated when “educational institutions underutilize the cultural resources and experiences of their working-class minority students” (Gonzáles et al., 2005, p. 168). When students feel like they are not an active part of the instruction or curriculum, it results in them becoming disinterested, feeling undervalued, and not actively engaging in instruction. In order to address this, teachers can create culturally relevant pathways for science learning by incorporating students’ and communities’ funds of knowledge into the curriculum.

Transformative researchers learn more about the community that they are serving in by paying attention to resources that promote community cultural wealth, so that they can bring cultural relevance to their instruction (Ladson-Billings, 1995). By “capitalizing on household and other community resources, we can organize classroom instruction that far exceeds in quality the rote-like instruction these children commonly encounter in schools” (Gonzáles et al., 2005, p. 71). Culturally-relevant science classrooms support diverse ways for children to develop, express, and share a cumulative understanding of science. Learning and assessment in science needs to provide diverse ways for children to express, develop, and gain conceptual understanding (Cowie et al., 2011). This was evident in Gutstein’s (2006) approach to engaging his students in real-world projects at Morningside Middle School.

Gutstein's (2006) Mathematics in Context curriculum created a space for his students to develop their sociopolitical consciousness. In one example, Gutstein's students calculated how many 4-year scholarships the government could offer to high school graduates from Morningside instead of manufacturing one additional B-2 war bomber. Students were engaged in questioning their calculations as well as in their position on the political issue. Gutstein approached teaching math in a meaningful and relevant way by connecting it to his students' lived reality, which allowed for his students to read and write the world with mathematics. Gutstein's unique pedagogy prepared his students to be in better positions to challenge the status quo and instilled a sense of social justice in his students (Gutstein, 2006). Controversial topics and a social justice curriculum can be applied in the science classroom when designing tasks that help connect science concepts with material that is relevant and familiar to students.

Similar to the social justice curriculum Gutstein's students attended to, science students in Zeidler et al. (2009) study explored socioscientific issues. As defined by these researchers, socioscientific issues were science-related, controversial social issues. The researchers found that students were attracted to debating issues that were relevant, which supported the development of their reflective judgment. This research had implications for rethinking how to connect science to topics that relate to a student's real world and are fundamentally meaningful. Socioscientific issues strengthen students' ability to consider multiple viewpoints as well as students' ability to integrate various strands of evidence into a position that is informed and data-driven, which is a fundamental life-skill that students can use in the real world (Zeidler et al., 2009).

Group-Worthy Tasks in the Science Classroom

> Working collaboratively with others not only enhances the understanding of science, it also fosters the practice of many of the skills, attitudes, and values that characterize science. Effective teachers design many of the activities for learning science to require group-work, not simply as an exercise, but as essential to the inquiry. The teacher's role is to structure the groups and to teach students the skills that are needed to work together (National Research Council, 1996).

Group-work provides students with an opportunity to work collaboratively with their peers. It is paramount that teachers use planning and anticipation to effectively construct learning situations for groups of students. Windschitl et al. (n.d.) discuss five lenses that teachers should consider: 1) authentic tasks (work that real scientists do), 2) assigning students to groups, 3) fostering student ownership, 4) interpersonal considerations, and 5) assessment and accountability. When these lenses are attended to, teachers can create a learning environment that gives students many rich opportunities to engage in science talk and develop pro-social behaviors (Windschitl et al., n.d.).

A group-worthy task is defined by five design features: 1) open-ended tasks, 2) multiple ways to show competence, 3) significant content, 4) interdependence and individual accountability, and 5) clear evaluation criteria (Lotan, 2003). Lotan (2003) explained that open-ended tasks bring relevance into the classroom, as they are more authentic than traditional, routine tasks. When students are active in this process, they realize that their class is not an abstract subject detached from real life. During these tasks, teachers assign intellectual authority to their students. When designing these tasks, teachers need to focus on components that require multiple intellectual abilities for task completion (Lotan, 2003).

Interdependence and individual accountability can play a large role in group dynamics. A one-semester long study performed in a 5th grade class by McDonald & Abell (2002) investigated these variables and found that there was a connection between two focal group's generative and authoritative discourse and students' knowledge and discourse development. Groups of four were randomly assigned and the researchers discovered that two focal groups differed in their discourse approach. Group 1 sustained generative conversations by rotating roles and jobs. Group 2 had occasional generative conversations but they could not sustain their generative discourse because they had dominant personalities and developed conflict over roles. Group 1 maximized their opportunity to learn through involving everyone in the group and participating in generative discourse with each other and with the teacher. Group 2 was more authoritative and had fewer learning opportunities. This study is relevant to education because it speaks to the importance of collaborative group-work and interaction between students and how that can affect learning of the material (McDonald & Abell, 2002).

One-dimensional, traditional tasks such as worksheet activities benefit some students, which creates academic status issues in the classroom because of differences in students' backgrounds. In order to address status during group-work, teachers need to set up norms and roles to increase equitable participation within groups. Very much like the High Leverage Teaching Practices (Kazemi, 1998), teachers need to be intentional in setting and maintaining expectations for participation. Roles for group-work can include: facilitator, resource manager, recorder, and team captain. These norms and roles might take a while to establish early on, but in the long run will save time and set up a positive learning environment where status is less of an issue. In addition, a task that allows for and required multiple perspectives to complete allows more students to make contributions to the group effort. Group-worthy tasks need to focus on a central disciplinary concept, where a big idea can be investigated and multiple standards are addressed. When done right, group-worthy tasks promote interdependence among students (Cohen & Lotan, 2014).

Group-worthy tasks focused on inquiry can promote student interdependence in the science classroom. Interdependence is a factor that is crucial across disciplines, but particularly important in the scientific discourse. When designing group-worthy tasks, the most important rule is that no student should be able to solve a complex instruction task alone. Stein et al. (2000) identified two types of tasks: lower level (memorization and procedures without connections) and higher level (procedures with connections and doing mathematics). The latter invited students to figure out relationships and build connections they had not already learned. It is important to note that expectations were set so that all students were accountable for their own learning and the product (Featherstone et al., 2011).

Development of Research Question

When it comes to achievement in science, researchers Hiebert & Stigler (2004) warned that curriculum reform is not enough. They found that effective change happens when teachers implement the problems in collaboration with their students. The researchers' recommended that teachers be intentional in their reflection to inform and guide improvements for their instructional practices. When teachers engage in reflective practices, they are building a new culture of teaching.

Seeing that there is room for improvement in the way science is approached, I wanted to be a part of this new culture of teaching. My hope was that I could help support my students in becoming lifelong learners, as well as aiding in their development toward becoming scientific literate citizens who would positively contribute to society. I wanted to create a safe, positive learning environment where students could test their own ideas and incorporate or adjust their peers' strategies. I believed that I could provide this learning opportunity for my students by engaging them in group-work.

Evident in the research presented in the literature review, there were benefits of inquiry-based, student-centered, collaborative group-work for all students. This is why I intended to look into the planning and implementation of group-work in the science classroom. My research question was: How do my practices around planning and implementing group-work affect student engagement with the material; specifically how are science talk and peer-to-peer interdependent development impacted?

CHAPTER 2—METHODS

Participants and Setting

My research took place at Karma High School, a public school with 1,100 students in grades 9 through 12. Karma is classified as urban and situated in an average-sized city in western Washington. There is a military influence in the school as a result of the school's proximity to a large Air Force and Army base. The student body is racially, ethnically, linguistically, culturally, and socioeconomically diverse with 78% students of color, 20% transitional bilingual, and 78% receiving a free or reduced lunch (OSPI Washington State Report Card, 2014). The students bring an array of personal, cultural, and community assets to the school. Many of these assets are highlighted in the student body's involvement in student groups such as athletic teams, JROTC, Hip Hop Club, Latinos Unidos, and Polynesian Dance Club (Yosso, 2005).

Karma High School offers multiple science classes including biology, chemistry, and physics. The biology classes are split into multiple sections, which include mainstream biology, English Language Learner (ELL) biology, and Collection of Evidence (COE) biology. The Biology staff collaborates to create the curriculum, based on biology EOC (End of Course) topics (Cells, Genetics, Evolution, and Ecology). Students are required to take one year of biology in their 10^{th} grade year and then take the biology EOC exam three to four weeks before the school year ended, so this affects when the material needs to be covered. This EOC exam is based on the current Washington State K-12 Science Learning Standards. Although Washington State is currently transitioning into utilizing the Next Generation Science Standards, these standards did not affect my instruction during this research.

Karma High School's daily schedule is set up in one-and-half hour block periods, with first bell at 7:25 am and school ending at 2:10 pm. My schedule for the duration of the research included one COE Biology class, one ELL sheltered Biology class, and three mainstream Biology classes. Unlike the other classes, the ELL class met every day and an ELL support teacher aided in lesson-planning and instruction every Wednesday. On average, each one of my mainstream classes and the COE class had 28 students, was balanced between female/male genders, and was representative of the student body. The ELL class had 24 students, was balanced between female/male genders, but was exclusively ELL and 95% students of color.

My classroom had a typical lab room setup, arranged in seven tables of four with attached sinks and two tables of four without sinks. There was a document camera and projector set up, with two white boards, and ample wall space to hang up GLAD (Guided Language Acquisition Design) posters. This setup was ideal for whole class instruction and discussion, independent work, partner work, and table group-work. Learning targets and the agenda were posted on the whiteboard daily, and unit standards were on a poster above the whiteboards in plain sight.

I collected my research during my student teaching, which coincidently was the time when I was performing my edTPA. The edTPA is a performance-based assessment that is required for all preservice candidates completing an approved Washington State teacher preparation program after January 2014. One requirement as per edTPA guidelines was having student permission forms for videotaping lessons. Due to this requirement, I decided I would select my period 2 Biology class for my edTPA, and this became the class for my research.

My research-selected period had 30 students, but since one student was absent for the entirety of my research, I did not include her in my data. My class had 19 female students and 11 male students, and was representative of the school racially, ethnically, linguistically, culturally, and socioeconomically. Out of my 30 students, one student was an 11^{th} grader, and the rest were 10^{th} graders. Students sat according to the seating chart devised by me, primarily with heterogeneous grouping in mind, but I made special considerations for six students. Of these six students, three students were arranged to accommodate their IEP plans, two were arranged to accommodate the use of home language support, and one student personally asked me to not be grouped with another student due to personal issues. This seating chart was adjusted three times during my data collection (10/13/2014, 10/24/2014, and 11/6/2014) to provide students with additional opportunities to work with different peers. It was in these table groups that students were assigned and worked collaboratively on group-work.

Although I taught in a mainstream Biology classroom, academic and content-specific vocabulary continued to be a challenge for some students. I paid close attention to academic language use during instruction and assessment. Learning objectives were structured around academic language and content-specific vocabulary development. I was fortunate to collaborate and receive feedback from my mentor teacher, who had been GLAD trained, and the ELL (English Language Learner) specialist for the school. In addition, for many students this was the first time in a formal lab setting, so lab and science skills were a top priority for instruction for the promotion of student discourse in science. I emphasized this by having a science lab safety and lab technique demonstration prior to starting all my labs.

This was an action research study where I served a dual role as a teacher-researcher. Due to my role, I needed to be aware of my own status and bias during my research. I was currently 26 years old and in a Master in Teaching program at The Evergreen State College. I graduated from Grinnell College in 2010, majoring in Biology. I had personally seen the benefits of working collaboratively in groups in the context of science and wanted to structure my instruction around group-work. I am racially Asian and ethnically Tibetan. I was adopted by white middle-class American parents and grew up middle-class overseas in four countries (Sri Lanka, Bangladesh, the Philippines, and Nepal). While living overseas I attended private American international schools. Being a third-culture kid growing up, I had the good fortune of being exposed to multiple cultures, which provided me a lens with which to look at groups of diverse individuals with empathy and compassion.

As communities in Washington become more diverse, my experiences put me in a unique position as an advocate for minority students, since I understood how they might be affected by societal biases. The ethnic, racial, and linguistic diversity at Karma High School reminded me of the diversity that I grew up with internationally. I felt very comfortable interacting with all of my students, regardless of their race, ethnicity, gender, etc. I found multiple entry points with my students as I developed interpersonal relationships. The fact that I am a teacher of color, an avid sports fan and player, and listen to popular music allowed me to engage in culturally-relevant conversations with my students. As I developed these relationships, there were many opportunities for exchanges of learning. These interactions showed me how important it was to ask my students about their culture and traditions and learn from them.

Description of Action

I collected the majority of my data over a five-week period starting in the beginning of October 2014. My action research was focused on my teaching practices around group-work. I implemented a series of six group-work tasks over the five weeks during which I collected, analyzed, and triangulated data as a means of evaluating my own teaching.

Every task followed the same format so that students could become familiar with the routine and expectations. The task started with a warm-up focused on the learning target for the day, which provided students with context. This warm-up served as a pre-assessment for the lesson, which determined whether or not I needed to spend extra time to teach a mini-lesson or meet with a smaller group of students. Students would rate themselves on their current understanding of the learning target(s) for the day. The task instructions were handed out in paper form and projected on the overhead. I went over the expectations and students had time to ask questions for clarification. The task rubric was handed out in paper form and projected on the overhead (refer to Appendix A). I went over the components and students had time to ask questions for clarification. Students would engage in the task while I was walking around and checking in with table groups. After the task was completed, students would self-assess on the rubric. At the end of the lesson, students would complete an exit ticket as a way to formatively assess their current understanding of the learning target(s). I used the exit tickets to determine the structure of the proceeding lesson's warm-up.

The first task that was implemented came from my edTPA mini-unit. This task required students, working in table groups of 3 or 4, to plan and implement their own investigation to help develop their understanding of the cell transport process, osmosis. This guided inquiry took two days for planning, one day for implementing, and one day for analyzing and presenting data. Therefore, the same groups worked together for the mini-unit, and this first task counted for four of my data collection days (10/1/2014, 10/3/2014, 10/7/2014, and 10/9/2014).

My mentor teacher and I both saw from student work for my edTPA lessons that students needed more practice in data analysis, conclusion, and procedure writing. Procedure writing was one aspect of the scientific process that the Biology teachers wanted to focus on as a data team goal because this was an area of the EOC that students had had trouble with in the past few years. We found that the two areas of procedural writing that needed growth were including the appropriate variables and adding more details. Therefore I structured my final five tasks around these processes.

The next task involved students working to analyze a given data set about plant growth and draw conclusions. The same groups were involved during this data collection on 10/16/2014 and 10/22/2014. The final separate four tasks involved students designing hypothetical investigations to test for photosynthesis and cellular respiration rates through procedural writing. During this data collection, the data collected on 10/28/2014 and 11/4/2014 were the same groups, and 11/6/2014 and 11/13/2014 were the same groups. During these tasks, I collected data in three different formats.

Data Collection and Analysis

I conducted a multi-level case study, looking at my own planning and implementation of student engagement in group-worthy tasks at the whole-class, table group, and individual student level. My action research was focused on my teaching practice, specifically evaluating group-work in my classroom. I adapted Cohen and Lotan's (2014) tools for evaluating group-work (student questionnaires, systematic quantitative observation, and use of recording devices). Specifically I was looking for student engagement in science discourse and involvement in equitable group-work. In order to investigate these characteristics of group-work I collected qualitative and quantitative data.

I wanted to utilize student voice in the form of student questionnaires and interviews. I triangulated this qualitative data with my research journal and systematic quantitative observations (whole class and individual) to guide changes in my planning and instruction. The five-week study captured data from the first full unit on cellular biology and the beginning of the unit on photosynthesis and cellular respiration. The majority of lessons were video recorded, my research journal was written on a daily basis, and student questionnaires and interviews (three focus students) were given at the start and end of data collection.

Research Journal

Since my research focused on my planning of the design of group-worthy tasks, I wanted to track my progression in the form of reflections on my pedagogical moves. I made daily journal entries and added comments during any analysis that I had done on that day. I also frequently debriefed with my mentor teacher to discuss the strengths and areas needing growth in my lessons. These comments were logged in my research journal as well. In addition to being a great resource for showing what I was thinking in-the-moment, the journal also served as a tool for reflexivity. This reflexivity involved self-awareness and critical self-reflection to track my own biases as they affected the research process. Journaling was not only valuable for my action research, but also a great reflective teaching practice to take on as a teacher. These field notes provided my in-the-moment perspective and were used to triangulate my other data sources. Since it was a primary source, this lent itself towards the credibility and confirmability of my study. This type of data source and collection method is a practice that can be transferred to other contextually similar settings.

Student Questionnaires and Interviews

Students were asked to fill out a questionnaire focused on their opinions of group-work at the beginning and end of my five weeks of research (refer to Appendix B). The purpose of this data source was to provide an alternate perspective on my teaching practice. The questions were aimed at student engagement with the material and attitudes towards viewing their peers as resources. In addition, three students (two female and one male) were selected and interviewed as focus students. These interviews were used to see if academic status played a role in peer-to-peer interdependent relationships (refer to Appendix C). I selected these students based on their current academic status, as well as my belief in their current understanding of content standards. The male student (student A) was classified as one with basic understanding of the standards, and the two females (student B and student C) were classified as those meeting and exceeding standards. The student responses were coded and tracked for patterns and served as a qualitative measure of change during the course of the research period. Data taken from these student questionnaires and interviews gave attention to student voice. I triangulated this data with my teacher journal and whole class and individual observations to guide my analysis to determine implications for designing and implementing group-worthy tasks in the future.

These primary data sources lent to the confirmability of the study, the triangulation of data strengthened the credibility, and attention to student voice attended to the transformative portion of my research, because the majority of my students were marginalized from the dominant culture.

Whole Class and Individual Observations

Whole class and individual observations were taken using two systems. The first system was adapted from Cohen and Lotan's (2014) tools for evaluating group-work and the second system was video recording.

The first system involved me walking around with a class list attached to a clipboard while students were engaged in the task. Using this, I would 1) listen for science talk, 2) look for students engaged in group-work, and 3) look for whether or not this group-work was equitable. I defined science talk as content-specific vocabulary, related to the task, and embedded in conversations between students. I defined group-work as students working on the task together instead of individually. I defined equitable group-work as students sharing the cognitive demands of the task. This looked like students analyzing and talking about a set of data together instead of having one student analyze and the other students take on other components of the rubric. To save time, I created my own symbols to represent these qualities, and they were as follows in the table below:

Symbol	√	X	OO	O	E	NE
Group-Work Qualities	Science Talk	Non-Science Talk	Group-Work	Individual Work	Equitable Group-Work	Non-Equitable Group-Work

My second system involved recording and examining video footage of the first six data collection lessons taught. These recordings were meant to catch group interactions with attention to respectful interactions and dialogue, equal sharing of responsibilities, and science talk that I could not keep track of while teaching. The recordings allowed me to take a more objective approach to my analysis of student engagement and interdependent relationships. The videos were divided into categories and analyzed for evidence of students engaging in science talk, group-work, and equitable group-work. This data was inputted into spreadsheets for analysis. In addition, I recorded my lessons to be viewed and analyzed by a group of my peers. The purpose of the peer review was to get varied perspectives and attend to my own bias in the analysis. The transcribed, coded recordings and the group analysis with my colleagues lent to the credibility and confirmability of my study.

Limitations to Methods

Overall, I learned a lot about my teaching practice over the course of this action research. During the five weeks of data collection, I attended to the procedure of data collection of all three of my sources. All three of my sources were extremely valuable in my analysis, but I did experience difficulties in their collection and analysis.

My research journal was always nearby during my instruction. I attempted to jot down notes, but this became a distraction when I attended to the whole class. In order to remediate this, I tended to my journal during my planning and lunch period. This did not provide me with 100% in-the-moment notes, but it provided me an opportunity to be reflective. These reflective notes were beneficial for my own teaching practice, as I found places in my instruction that I wanted to change. I also utilized this journal while watching my video recordings by myself and also in my peer review. This served as a tool to compare my own thinking with alternate perspectives.

The student evaluations were equally important for my development as a teacher and in my analysis. Although some students provided more feedback than others, this attention to student voice gave me an honest student perspective regarding my teaching. Since I wanted to gear my instruction to fit my students' needs, these evaluations allowed me to track patterns of my strengths and areas for growth. By looking to improve these areas for growth, I tailored my lessons to attend to a learning environment that gave students many rich opportunities to engage in science talk and to develop pro-social behaviors. Students also appreciated that I looked for their feedback, and I plan on continuing to use these evaluations in my teaching.

Although the video recordings produced clear images and sound, the shear length made the analysis process very time-consuming. I thought that the peer-review process of the videos proved to be more helpful in my analysis than the transcription, because it was a group analysis as opposed to an individual one, and therefore I attended to my own potential bias.

When reviewing my methods, there were aspects of this study that could have threatened the validity. The first threat to validity was my own bias and positionality as a teacher-researcher throughout the process of this research. This was particularly true when it came to assessing for science discourse, group-work, and equitable group-work. This bias comes from the fact that I was the one who determined what science discourse and equitable group-work looked like. I came into this study with the purpose of improving my own practice in planning and implementing group-worthy tasks. The subjectivity in my journal and analyzing of video footage influenced the transferability and confirmability of the study. In order to address this, I utilized multiple sources and peer-review to attend to my own bias. The peer-review process included two peers who were labeled as *insiders*, or those who had background knowledge on group-worthy tasks and/or science, and one peer labeled as an *outsider,* or one who had little to no background knowledge of group-worthy tasks and/or science. This peer-review process strengthened the credibility and confirmability of my study.

The second threat was the relatively short-time frame of the study as per time constraints of the edTPA and the 10-week long student teaching quarter. This threatened the dependability and transferability of the study. The majority of research that I investigated to aid in my conclusions had months to years of study; therefore this might have weakened the consistency in my findings with other similar studies. In order to strengthen the dependability of my study, I attended to a variety of details revolving around the context of the study. I provided background information about the context, culture, demographics, and setting of the research site. I also included information about the study participants, classroom set up, and how the action was carried out. If someone else wanted to replicate my study, they could follow my rich and thick description; however, if they wanted to turn this into a longer time frame they would need to attend to the methods. Although this five-week long study did not have prolonged and persistent engagement, there still was an interactive link between my students, my peers, and myself in the form of student evaluations and video peer reviews. The data collected allowed for triangulation, which attended to the credibility and confirmability of my study and aided in the conclusions that were made.

CHAPTER 3—FINDINGS AND IMPLICATIONS

This action research project examined the implementation of group-worthy tasks in my Biology classroom. I wanted to see how these practices affected student engagement with the material, in particular how they impact science talk and peer-to-peer interdependent development. In order to analyze this question, I collected data from a variety of sources over five weeks. I gave my students six group-worthy tasks, conducted pre- and post-questionnaires, interviewed three focus students, maintained a research journal, video-recorded groups and made whole-class and individual observations as students engaged in group-worthy tasks. Through my analysis I found two major findings revolving around science discourse and peer-to-peer interdependent development and one theme that was embedded in both major findings.

The first finding was that, over the course of my five weeks, students began to engage in science talk more frequently. This was evident in my whole class and individual observations and was supported by video footage, student questionnaires, and interviews. The second finding from my analysis of whole class and individual observations was that although the majority of group members engaged in group-work, this group-work was not always equitable. Student questionnaires and interviews helped me determine what impacted equitable group-work, and this shed light on the group's peer-to-peer interdependent relationship development. The theme that was embedded in the previous two findings was that science discourse and peer-to-peer interdependent development seemed to be influenced by the amount of time a group had worked together on the task. I realized through my research journal that I had changed the seating chart three times during the course of my research, which required students to start working with new group members. Based on data in student questionnaires and focus-student interviews, this changed within-group dynamics between students and affected discussion and group-work.

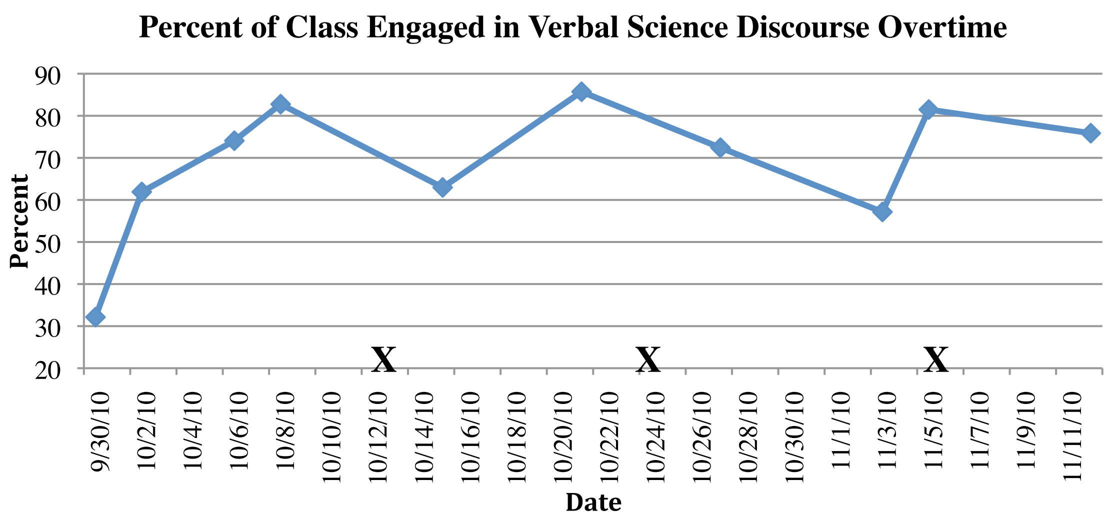
In this chapter, I will first discuss my findings and supporting evidence. Then I will discuss the implications based on my findings and will make connections to the studies researched for my literature review. Afterwards, I will identify potential future areas of research that have grown out of my findings. Finally, I will discuss the limitations to my conclusions.

Increased Science Discourse

Through my analysis of whole class and individual observations, classroom video, research journal, and student questionnaires and interviews, I found that there was an upward trend in students engaging in science talk. Science is heavy in content-specific vocabulary and this vocabulary is not a part of students' everyday discourse, therefore students need ample opportunities to engage in conversation to help with vocabulary acquisition.

When I made whole-class and individual observations, I listened for groups and individuals engaging in conversations that included content-specific vocabulary related to the learning task. For example, in the first task, I listened for vocabulary such as passive transport, osmosis, and hypertonic solution. In addition, I only recorded as an example of using science discourse, if the term or concept was used correctly. I recorded these observations in-the-moment, but I also referred to classroom videos to cross-check to see if my observations were accurate. I quantified these observations to see what percentage of the class engaged in conversations with content specific vocabulary for each day of my data collection. This information was presented in the graph below to show how these quantified observations changed overtime. The X denotes when a seating chart change was made.

Graph 1



The first data point seemed to be an outlier, so I referred to my research journal to look for my notes on my lesson. I attributed the low percentage (32%) on 10/1/2014 to the way the task was introduced. The guided-inquiry task required students to come up with their own investigative questions and design their investigation. According to my research journal, my set up (warm up, introduction, instructions) took longer than expected and as a result the majority of students worked on their initial investigative questions by themselves and did not get into the group-work portion of the task.

The graph showed an increasing trend for the first four data points, which came from the first task, and the next two data points, which came from the second task. These were the only two tasks in my research that took longer than one class period to complete, therefore the same group worked together on the same task. As indicated by the X in the graph, a seating-chart change occurred between these two tasks, so the groups' members changed. In these two tasks, groups engaged in conversations that included content-specific vocabulary. One observation from my research journal on 10/3/2014 was that group members modeled how to use content-specific vocabulary appropriately. This invited other group members into the conversation, and helped students understand the concept or term that was discussed. This was supported in a transcribed portion of the video from 10/7/2014 where one group of students were analyzing their data:

> Student 1: The potato in the beaker got smaller because the salt dehydrated the potato?
>
> Student 2: The potato slice decreased in mass because it was in a hypertonic solution.
>
> Student 1: Why?
>
> Student 3: Remember the pictures we drew for osmosis? Hyper…like losing water when we are hyper.
>
> Student 2: The potato slice is representing our cells. When the outside environment is concentrated, the water will leave the cell causing it to dehydrate.
>
> Student 1: So I was right? The potato decreased because there was more salt outside the potato. [Pointing to notes] The potato was in a hypertonic solution. This is the potato, so the cell. Dots are the salt. The water goes to the concentrated area?

In this exchange, Student 1 was able to talk with his group members. Student 2 modeled the vocabulary and she helped Student 1 with his content understanding. Student 1 started to use content specific vocabulary in his discourse. This collaborative process to help understand concepts and terms aligns well with why many students in my class enjoyed group-work. These are two responses to the question "What are the reasons that you enjoy or do not enjoy group-work?" from two different students from the final questionnaire taken on 11/13/2014.

> Student 1: I like working in groups because you get to discuss & work w/ people. I can ask for help if I don't get something. I think it is because you learn more.
>
> Student 2: Because some people in your group may understand some logical topic or vocabulary better than [you] so they will explain it better to you.

Similar to this, in the post-interview on 11/13/2014, focus student A responded to the question "What makes a successful group-work experience?" by saying "I really liked being in groups that had people who understood the vocabulary. They would use it and explain it to me, so that I could use it in the future. Another thing that makes us successful is when we have worked with the group longer. It's not as awkward and you are on a roll, because you worked with them already." The group-worthy tasks provided a space for students to engage in conversation, and this allowed for students to practice and use vocabulary. I believe this caused the increase in the percentage of the class who engaged in verbal science discourse. In addition, the time element seemed to contribute to developing interdependent relationships between students in their groups.

The last four tasks were shorter group-worthy tasks that only took one class period to complete. A seating change occurred on 10/24/2014, so there were newly formed groups for the 10/28/2014 and 11/4/2014 tasks. During these tasks, there was a downward trend for percentage of the class who engaged in verbal science discourse.

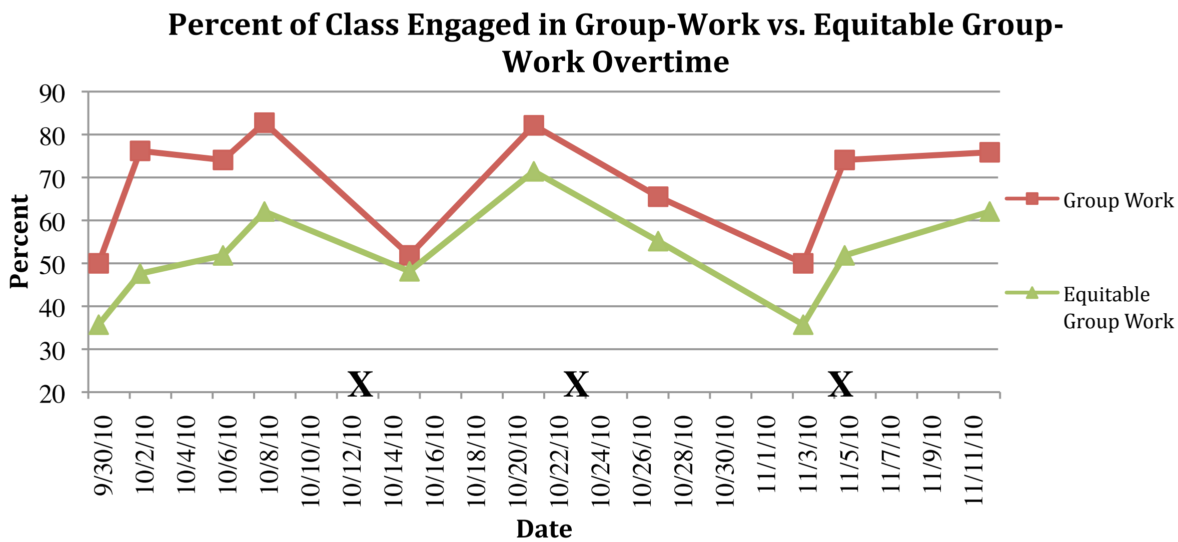
According to my research journal input for 11/4/2014, in my analysis of the lesson for the day, I commented that three groups did not engage in group-work and decided to attempt the task by themselves. In these groups, the students performed individual work and did not consult their peers. This motivated me to change the seating chart for the following day 11/6/2014 in an attempt to encourage groups to work and talk together. A lot of variables could have attributed to this decrease in discussion, such as personality conflicts, engagement with the task, or external factors that had occurred outside of my classroom. To gain insight into student opinion, I referred to my focus student's interview responses. In addition, I also referred to my research journal to comment on discourse.

In my interview with focus student B, she shared her opinion on when group-work does not work in her post-interview. Referring to my research journal, focus student B had been one student who was in a group that ended up working independently during the tasks on the 10/28/2014 and 11/4/2014. The interview question was: "What has been your experience working with your group in this class?" She responded: "It depends on which group. The group I was working with during the procedure writing… I did not like them. We had too many big personalities. I don't like [blank] and she doesn't like me. We kept butting heads and the other two people didn't want to work. So I just did me and got what I needed to get done." I followed up by asking: "Did you try talking to them?" She responded: "Nothing needed to be said. This is why group-work doesn't work all the time." Focus student B did not like her group and therefore would not work with them. When she worked by herself, she did not talk with her group members. Once I changed the seating chart for the final two tasks, she was in a new group, and she readily engaged with her new group. In my interview, I asked what had changed, and she commented on having to depend on her group, which alluded to peer-to-peer interdependent relationships between peers.

Inequitable Group-Work

Similar to my analysis for evidence of discourse, I used whole class and individual observations, classroom video, research journal, and student questionnaires and interviews to look for evidence of peer-to-peer interdependent development. When I made whole class and individual observations, I looked to see if students were engaging in group-work. This looked like groups who talked and worked together, as opposed to those who worked on the task individually. In addition, I only recorded the interaction as equitable group-work if I saw that everyone in the group was engaged in an equally cognitively-demanding portion of the task. One example of this was when all members in a group analyzed the data and talked about it. I recorded these observations in-the-moment, but I also referred to classroom video to cross check to see if my observations were accurate. I quantified these observations to see what percentage of the class engaged in group-work for each day of my data collection. This information was presented in the graph below to show how these quantified observations changed overtime. The X denotes when a seating chart changed was made.

Graph 2



The first finding was that although groups engaged in group-work, this was not always equitable. A correlation that I found between my observations, my research journal, and my student questionnaires was that the majority of my students (n=26) said they enjoyed working in groups. However, more than half of the students responded similarly to this question "What are the reasons that you enjoy or do not enjoy group-work?" One male student's response was "When everyone in the group gets done what needs to be done by the time it needs to be done." A female student echoed this in her response, "I only enjoy group-work when all partners are working well and doing the same amount of the work. Otherwise, what is the point of group-work?"

Evident in the graph above, in every task I observed that, in-the-moment and verified through video, group-work was not always equitable. This pointed to how one male student responded in his questionnaire. The question was "Is group-work more valuable than working independently (by yourself)?" This male student said "To me, when I work alone I know what I am doing. I know that if I mess up, I am the one who messed up, and it is my grade. When you are in a group, you do not know who you will be partnered up with. This could mess up your grade." This response reinforced the point that many students (n=16) said that group-work is valuable, but it depends on the group members. This could explain why I observed, in-the-moment and through video, students dividing tasks, but some group members taking a larger part of the task on. For example, in the first task, the final product was a group poster. There were different sections on the poster that needed to be completed, so groups divided up each section. However, analyzing data and writing a conclusion required a higher cognitive demand than creating a data table. This was a common theme that I wrote about in my research journal. I wrote that I believed that status played a large role in this, but this was not an area that I chose to research. I wondered what implications there might be in equitable group-work on a statement about status and interdependent relationships between students. It made me later revisit the way that I set up group norms, expectations, and specific roles. I was not intentional with these aspects of group-worthy tasks, and as a result I believe this negatively impacted student interdependent relationship-development.

My second finding was that there were some individuals that did not want to engage in group-work at all. Through video footage and my research journal, I found that there were two students that always chose to do separate work, even when I encouraged them to work with their groups. In-the-moment, I did not want to confront this head-on. It was frustrating and this was evident in my research journal. I did comment in my journal that this was a form of differentiation, but I was frustrated because I was trying to get students to develop interdependent relationships. I was curious to see what factors influenced these two students' decisions to work alone, so I looked at their questionnaires to track their responses.

In the questionnaires, I found that both of these students responded the same way in both their pre- and post-questionnaires. The question was: Is group-work more valuable than working independently (by yourself)? The first student responded: "No, I'm not really one to like working with more than one person. I don't like having to warm up to others. I lose my patience very quickly." The second student responded: "I don't like group-work because not everyone gets to express their full knowledge. Sometimes [they're] stuck up and stiff or lazy. Sometimes one person takes complete control." The first student was one who I documented in my research journal. She did not want to work in a group-work setting, and was one of the students who did individual work for every task. She even came in after school to complete her lab so that she would not have to rely on her peers. She did not actively participate in discussion in class and relied on her notes and textbook to gain content understanding. As a result of her not engaging in discussion, she did not get to test out her understanding with her peers, and did not perform well on the tasks or unit summative assessments. The second student also ended up doing individual work for every task. She, on the other hand, came into the class with prior knowledge of Biology. She did not like working with others, but performed well on the tasks and unit summative assessments. I have to consider students like these two when I implement group-work in my classroom. There are implications for what to consider when I plan to integrate norms, expectations, and roles around group-work in my classroom.

My third finding was that over time, with the exception of the tasks on 10/28/2014 and 11/4/2014, more groups engaged in group-work. A variety of factors could explain this. A recurring point that I made in my research journal was, I believed, that one possible factor was that the deadline for the assignment encouraged students to work together to get the job done. This was supported when I reviewed video footage. I noticed that towards the end of the period, more students seemed to be engaged in group-work. On video footage of the second task on 10/22/2014, I heard one student say to another student in his group, "[Blank] get over here now. We need your help otherwise we won't get done." The sense of urgency to get the task complete was evident in the student's demand. The student saw his peer as an asset that could help finish the task. This correlated well when I reviewed student questionnaires and there was a commonality in student responses to my question: "When has group-work been valuable to you?" Student responses included "when we have a big assignment", "when a project is due", "group-work should be valuable when it is a big project", and "when we are doing a big project". These student responses provided insight into what students thought the benefits of group-work were. I do not know if I can conclude that those students who engaged in group-work developed positive interdependent relationships with their peers, but students did see their peers as assets. In addition to video and questionnaires, I analyzed my focus students' interview responses.

Focus students A and C both were in the same group for the first task. When I interviewed both of them at the end of my research, they both provided their perspective about why groups started working together more. I asked: "Do you feel like your group member helped you? If so, how so?" Focus student A said: "When I don't understand the topic completely I feel that my group members can push me & help me understand better. I know that [focus student C] is smart and I didn't want to mess up our grade. But I like asking questions. I asked a lot of questions and [focus student C] helped me understand. I started getting what we were doing. Then I talked more and this is why I feel like my group members helped me. Our group got a flow going after the first day." Focus student A saw his questioning strategies as something he added to his group. He initially was reluctant to contribute because he did not want to affect his group's grade. After the first day, he saw that his group was working together more efficiently. This was echoed in focus student C when she said: "This was the first time we all worked together. I did not want to take complete control of our group, but I did not really want my grade to get messed up. After the first day, my group started adding more, and they were very helpful when we were setting up the lab and during data-collection. We all shared ideas and helped each other with the work. Everyone had something to contribute." Focus student C was hesitant working with her group, but after seeing that her group members contributed, especially during the lab, she saw them as assets. This positive interdependence between peers was my goal behind implementing group-work in science. This was not the experience in every group, so this has implications for how I structure and set up group-work in my classroom.

Implications for my Teaching Practice

Through my analysis of the findings, I developed implications for my teaching practice. I outlined what would have been necessary to fully implement group-worthy tasks in the future. In addition, I referred to my literature review to help me have insights into why my action worked or did not work.

Based on my finding that there was an upward trend of science discourse as groups continued to work with one another, this informs me that I need to set up many opportunities for students to engage in discussion. These opportunities could take the form of group-worthy tasks, but I see the benefit in partner work, labs, and turn-and-talk strategies too. These smaller-scale learning opportunities allow students to talk to each other and practice content-specific vocabulary. When large emphasis is placed on collaborative learning, dialogue is more likely to occur (Wells & Arauz, 2006). My goal is a student-centered classroom where teacher talk is limited, and I believe that building a collaborative learning environment will help me work towards this goal.

Another implication for my practice revolves around designing assessments for group-worthy tasks that require individual and group accountability. This recommendation is in response to my findings that some students resorted to working individually and that not all group-work was equitable. Individual and group accountability can be increased using an individual report, role cards, specific norms, and a participation quiz (Cohen & Lotan, 2014). An individual report is an individual summative assessment collected at the end of the task. This may encourage students to rely on each other more, and therefore increase collaboration. Role cards give each student in the group a specific role to attend to during the task. Some students may need more experience working in a group setting, so role cards could give these students a task to focus on that would help the group. Specific norms, such as *everyone in the group can explain*, presented prior to the task and then debriefed at the end may help with individual and group accountability. A participation quiz is a low-stakes way of encouraging students to exhibit pro-social behaviors (Windschitl et al., n.d.). While groups are engaged in the task, the teacher's role is to walk around and observe for groups attending to the norms specific to the task. The teacher displays group examples and anti-examples of these norms publically in the classroom. This public display can be debriefed during the lesson and/or the end of the lesson to highlight the examples and attend to the anti-examples.

When I design group-worthy tasks, I need to pay attention to all five design features outlined by Lotan and Cohen (2014). In particular, I need to set and maintain expectations for participation (Kazemi, 1998). I know that in heterogeneous groups, status can play a huge role in the amount of participation and achievement students' experience. In my findings, I found that students were concerned about how they or their group members would affect their grade. This influenced how students contributed to the group. Focus students A and C represented students who had low and high academic status. Through working together on the first task, they both realized that they had ways to show competence, and saw each other as assets. I am a proponent of allowing students to show multiple ways to show competence. By allowing students to bring these multiple "smarts" to the table, students see that having multiple perspectives or approaches to a topic can aid in the group's overall understanding, thus promoting interdependence. Like other research that looked at inquiry-based approaches, Lotan (2003) commented on these tasks being well-designed, which requires time. I need to keep this in mind, and realize that this approach may be novel to many of my students, so getting them used to the idea of co-constructing knowledge may require modeling and time, especially those students who have thrived in a more traditional classroom setting.

Suggestions for Future Research

One area of research that I would like to purse revolves around how to assign students to groups. One recommendation by Cohen and Lotan is randomized seating to help develop interdependent relationships between students (2014). I did not use random seating assignments in my student teaching experience. Through my findings I found that some students would refuse to work with others. This was either made public by the students or said privately to me in surveys or personally. Ideally, I want all of my students to work with each other to help develop interdependence between all my students. In order to adjust how I approach my grouping practice, I was interested in what my students had to recommend. Through questionnaire and interview responses, I found that a student recommendation to make their group-work experience more beneficial was allowing for students to decide with whom they work. I do worry that this suggestion has the potential for setting up status issues between students in the classroom.

I also saw that from my research that I needed to be intentional with setting norms and expectations around group-work. I did not use roles and did not have norms explicitly stated on the task cards I used. Through my findings I found that equitable group-work was not always attended to. In addition, I found that in some groups, students did not want to talk to each other. This is why I want to pursue research in setting up norms and expectations around group-work. This includes how members should work in a group setting, such as roles and the expectation that students listen and orient each other’s ideas. I want group-work to be integral to my instruction, because I want to decrease teacher-centered instruction, increase student-to-student discussion, and provide opportunities for students to co-construct knowledge to show their understanding.

Another area of research that interests me is how to promote individual and group accountability. Through my findings, I found that in some groups students chose to take on the task individually. I also found that groups that did choose to work together did not always engage in equitable group-work. I often saw students take on larger portions of the task because they were afraid of how their group members would affect their grade. Suggestions by Cohen and Lotan (2014) include implementing participation quizzes and individual reports during group-work. In my student teaching, I did not include either one of these in my tasks. This may have attributed to the lack of group accountability, which allowed students to work individually. This also may have attributed to the lack of individual accountability, which allowed for non-equitable group-work.

If I had more time in my study, I would have returned to my research site and share my results with my students to engage in a member check. This would have attended to my potential biases and therefore would have strengthened my credibility and dependability. I would want to share my methodology and findings to see if they were believable and convincing to my study participants. This would also strengthen the transformative aspect of my research by providing another opportunity for student voice. I would be able to develop more insights and implications to improve my own practice for implementing group-work in science in order to attend to status and peer-to-peer interdependent relationships.

Limitations to Findings and Implications

I recognize that as a teacher-researcher, I provided the sole analysis of my data. Although I had peers, both insiders and outsiders, who helped with my analysis, I still made the final calls in how I interpreted my findings. I recognize the potential bias in my analysis and therefore admit that my findings and implications may be biased as well, so I heed caution to the reader. However, my hope is that the reader can look at the research in my literature review, review my methods, look at my findings and implications and see potential in attempting to implement group-worthy tasks in their own classroom.

Closing Comments

The purpose of this study was to investigate my own implementation of group-worthy tasks in the context of science. Through this action research project, I was hoping to better understand how these tasks would affect my students' engagement with the material, particularly how students engaged in science talk and developed peer-to-peer interdependent relationships. Through my analysis I have further developed my understanding of implementing group-worthy tasks, particularly what task design features I need to develop for my own teaching practice.

I know that learning science has been likened to learning a second language because of the amount of content specific and academic vocabulary. Therefore there is a need for students to engage in science discourse in order to help with vocabulary acquisition. I believe that group-worthy tasks provide students an opportunity to do this. Task design developed around a cognitively demanding task, increases the likelihood for students to talk to each other. In addition, students begin to develop interdependent relationships among their group members. However, this interdependence is influenced by a variety of factors, one of which is time spent working with a group. I know that group-work will be a large part of my instruction, so I look forward to further developing my own teaching practice around the designing and implementing of group-worthy tasks.

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APPENDICES

Appendix A

Scoring Rubric for Osmosis Lab Poster

Component	Level 1	Level 2	Level 3	Level 4
Procedure	Student's procedure has only 1 attribute, or 2 attributes with limited errors.	Student's procedure has 3 attributes with limited errors	Student's procedure has 4 attributes with limited errors.	Student's procedure has 5 out 5 of the attributes with no errors.
Data Table	Student's data table has 1 attribute.	Student's data table has 2 attributes.	Student's data table has 3 attributes.	Student's data table has all 4 attributes.
Analysis	Student's analysis has 1 attribute.	Student's analysis has 2 attributes.	Student's analysis has 3 attributes.	Student's analysis has all 4 attributes.
Lab Components	Student's poster is missing components.	Student's poster has all components, but has major errors.	Student's poster has all components, but has minor errors.	Student's poster has all components, with no errors.

Final Score: ______________

Comments:

Appendix A Continued

Procedure Attributes	Description of Attribute	Attributes (Qualities)
Controlled Variables	**At least two** controlled variables are identified in the procedure or the materials list	1
Manipulated Variables	Only one manipulated variable is identified in the procedure or data table. The manipulated variable must have **at least 3 conditions** to be credited.	1
Responding Variables	The responding variable is identified in the procedure or data table.	1
Record Measurements	The procedure states measurements are recorded.	1
Logical Steps	The steps of the procedure are **detailed** enough to repeat the procedure effectively.	1
	Total Possible Attributes (Qualities)	5

Data Table Attributes	Description of Attribute	Attributes (Qualities)
Correct Labels	Controlled, responding, and manipulated variables are clearly labeled.	1
Correct Units	Units are evident and correct.	1
Captured All Data	Measurements for initial, final, and change in mass.	1
Correct Calculations	Calculations for change in mass are correct.	1
	Total Possible Attributes (Qualities)	4

Analysis Attributes	Description of Attribute	Attributes (Qualities)
Patterns in Data	Find and state patterns in data (between manipulated and responding variable) in discussion of analysis.	1
Points to Evidence	Includes data with correct units in discussion of analysis.	1
Talks About All Data	Mentions all data in discussion of analysis.	1
Connect to Science Concepts	Connect evidence/findings to the science concepts (vocabulary and terms).	1
	Total Possible Attributes (Qualities)	4

Appendix B

Questionnaire

1. Do you enjoy or not enjoy working in groups?
2. What are the reasons that you enjoy or do not enjoy group-work?
3. Is group-work more valuable than working independently (by yourself)?
4. When is group-work valuable?
5. When has group-work been valuable to you?

Appendix C

Pre-Research Interview Questions

1. What is your opinion on group-work? Why?
2. What experiences have you had with group-work?
3. What has been your experience working with your group in this class?
4. What makes a successful group-work experience?

Post-Research Interview Questions

1. What is your opinion on group-work? Why?
2. What experiences have you had with group-work?
3. What has been your experience working with your group in this class?
4. What makes a successful group-work experience?
5. What would you want to change to make your group-work experience more beneficial?
6. Do you feel like you contributed to your group?
7. Do you feel like your peers contributed to your group?
8. Did you feel like your group members helped you? If so, how so?
9. Did you feel like you helped your group members? If so, how so?