UNIVERSITY OF CALIFORNIA, SAN DIEGO

Critical Thinking through Writing:

Expressing Scientific Thought and Process in a Deaf Classroom

A Thesis submitted in partial satisfaction of the requirements for the degree

Master of Arts

in

Teaching and Learning: Bilingual Education(ASL-English)

by

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The Thesis of Leslie Manjarrez is approved and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

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Dedication

The completion of this thesis could not have been possible without the community of people behind me, for no child is raised without a village

This work is the result of many hours (years really) of patience on the part of my parents, brother, partner, roommate, friends, past and current teachers, professors, community members, peers, and Bailey.

Without your words of encouragement and wisdom, re-teaching, cuddles, positive outlook on life, smiles, endless conversations, bottomless cups of drinks, and unconditional love I would have never made it this far.

For every moment I thought I couldn't, there were always people pushing me and telling me that I could. Thank you for making me believe, now I will help others believe they can too.

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ABSTRACT OF THE THESIS

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University of California, San Diego, 2013

Tom Humphries, Chair

Within Deaf classrooms there is often a disconnect between academic areas and writing curriculums that develop in both common and academic language, where often classrooms focus solely on writing as a skill rather than as a method for producing language through an academic area. This work focuses on the development of academic language in ASL and English print of science. The curriculum is written to be implemented as a bilingual academic curriculum to support Deaf and Hard of Hearing students in various self contained classroom settings. Lessons are conducted in three Units, A B and C. Unit A focuses on research, thought and writing of preparatory materials in small groups. Unit B is comprised of procedural lessons on conducting

experiments and the evaluation of those experiments through mathematics. Unit C is a group of lessons that ties together Units A and B through writing and peer teaching as a method of concluding the work and presenting information in an effective manner. The success of the project was evaluated on the basis of student work, rubrics, and final works from the students. The results showed promise in aspects of Critical Thinking, writing development, and expression of new concepts in both ASL and English.

I. Introduction & Overview

The need for critical thinkers goes beyond the classrooms whereby the students continue actively participating in society. Critical Thinking within the scientific process is a skill that can be applied to various aspects of academic learning as well as life skills.

In an age where common core will integrate literacy as a large portion of the science expectations; science literacy, cooperative learning, and Critical Thinking should be at the forefront of science curriculum. This is especially true for Deaf students, for whom reading and writing requires extra support to build literacy across two languages. My approach is founded on principles of classroom community, building cooperative learning, Critical Thinking, and student led projects using a bilingual approach to the method of teaching. My intent is for this curriculum to be used in all Deaf classrooms, from mainstream programs to residential schools, as a method to expose and explore understanding of science as an academic content area beyond its connection to math and extend this understanding to writing, reading, and the need for thinking beyond facts, through explanations and discussions in class.

This curriculum was built upon the following goals for the students:

1) Creating and designing an experiment to showcase an idea, concept or thought of a scientific topic or concept.
2) Analyze and evaluate self and peer work as part of editing and improving writing as a process.
3) Discussion in peer groups the texts or topics related to scientific process and concepts.
4) Improve or develop Critical Thinking skills through analysis of texts/discussions/peer-sharing throughout the process.

The current methods of teaching a Deaf classroom focus on language acquisition and the development of vocabulary in English as a central theme to learning. Another approach is the focus on the ideology of having students learn two languages at the same time, known as the bilingualism approach. This approach is one that is central to my thesis as a method of empowerment and access for students.

II. Discussion on the Bilingual Approach

My approach to the education of Deaf children is to take their existing experiences and implement them within the context of classroom literacy. Although there are many arenas in which this literacy competency may take place (i.e Hearing/Deaf, ASL/English, Self Contained Classrooms/Mainstreaming), there are many ways in which students can express their position as students and as contributors to the classroom at a deeper level than as simply passive participants. The vision for this curriculum is to address the need of academic language development within a specific, often tough, content area of physics. Students are expected to apply skills from other content areas where decisions, ideas, concepts, and language practice become a function of analysis of literacy skills to promote Critical Thinking development and academic language fluency to support Deaf students in reaching their full academic potential.

Current research addresses the differences between approaches to literacy within science and the development of bilingualism as a function of explicit instruction in conjunction with the development of identity. Often content areas such as science often get less classroom time for implementation because they are seen as too focused on English or that there is not enough time to teach both the necessary vocabulary and reading skills needed and teach science in the classroom. Often the idea of focusing on one language then transitioning to another is very different from incorporating both into a curriculum where an academic content area is also present. Science is seen as facts, and those facts are often presented only in English print whereby, students often struggle with the transition between reading the facts to showing the concepts in ASL. However, in a

bilingual setting where science and other core academic subjects are taught, the marriage of ASL, English, and academic language fluency is at the forefront; it is the central idea of a classroom catering to a bilingual approach.

This central theme of the curriculum is intended as a means of educating the Deaf bilingually. In addition to this, the approach of the curriculum intends to support the linguistic advances of the students in two languages: ASL and English. In this method, access to the content and the use of analysis through both a visual spatial language (ASL) which they know, and a language that is written (English), the students will develop and utilize academic language for the purpose of analysis and discussion in both languages.

Students are encouraged to view their ideals and experiences as part of a more holistic perspective of themselves within the classroom community. Students will form groups in which they are equal contributors to the discussions and processes related to the topic of science exploration. The curriculum emphasizes group work and collaboration which is the cornerstone of collaborative learning. In essence, collaborative learning becomes a part of the classroom culture that influences student learning on a peer to peer basis whereby the teacher acts as a facilitator of learning. In the facilitator role, the teacher provides models for language and literacy development, and the students are responsible for the exploration and collaboration involved in learning the content.

The arguments in support of a bilingual approach and perspective are three-fold: a research argument, a pedagogical argument, and a socio-cultural argument. The research based argument draws on studies which have been conducted which demonstrate that when bilingualism is a central ideal in students lives it allows students to reach a higher

level of education, have metacognative advantages to language learning, and have a unique perspective and approach to learning segments. Bilingualism as a function of mental capacity provides a greater mental flexibility and the ability to think more abstractly (Peal and Lambert, 1962). This significant piece of research allows us a lens from which to view the benefit of Deaf students developing both English and ASL. Students who have a bilingual background are able to take views from different perspectives and they have a greater capacity to "think outside the box" for creative or non-intuitive answers. Cummings(1975, 1977) found that bilinguals who are categorized as "balanced" bilinguals, were superior in the areas of fluency and flexibility with verbal divergence. Thus, it is plausible that Deaf students in a bilinugal English-ASL classroom become balanced bilinguals with this greater cognitive growth. To further this argument in terms of the metalinguistic awareness, Ianco-Worral (1972) spoke to the "separation of names and objects" done by bilinguals, where names for objects are not singular and can be replaced and interchanged as needed. This showcases the idea that objects stand apart from their labels, a result of knowing two (or more) languages giving bilingual children an awareness of a free, non-fixed relationship between the words for objects and the objects themselves, which gives rise to variable and possibilities in creativity or thinking beyond the label of an object (Ianco-Worral, 1972).

A pedagogical argument for a bilingual approach for this curriculum is that Critical Thinking should be a central goal to all learning. Students are encouraged to explore their experience and analyze critically choices that they make and that have been made for them in a historical context of the Deaf experience (Paulo Freire, 1970).

Through the critical choices they make in expressions of language, students are not only able to reflect and write about their experiences, but they are also encouraged to discuss critically their viewpoints in the classroom using their language expression to others in the classroom. With this kind of Critical Thinking, which is explained by Mulnix(2012) as the "ability to grasp inferential connections holding between statements"(pp.75) students can assess truth and fallacies in written work and form their own opinions in texts based on arguments. These arguments are a basis in constructing ideas and stances from different perspectives and points of view based on experience. Critical Thinking is also defined as "the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" (Glaser, 1941, pp. 34). In this definition, the students would not only grasp concepts as in the previous discussion of constructing ideas, but also actively apply those ideas and thoughts to their experimentation procedure as a method for clear communication with other peers. Behind using this approach to the curriculum is the goal to have students empower themselves with information and process individually and in small groups the decisions, procedures, facts, and ideas that are relevant to themselves, their scientific topics, and how to present them to others.

The last argument for the approach is based in socio-cultural benefits of this project. The argument for this curriculum, which is intended to be founded on supporting student learning through multiple perspectives and experiences of the classroom community, is that with the learning segments aimed at allowing multiple student

perspectives on topics in science are to be utilized in a classroom, from what materials to use to which steps should be taken to complete the experiment. In this way, students' lives will be enhanced as they move between and into real life experiences outside the classroom where they and others bring different abilities and perspectives. In practice, multiple perspectives are to be planned and implemented so that students explore content together with peer to peer relationships. Along with scaffolded support for exposure to the academic and common language needed to discuss, debate, and create a process, students need to learn how to work together. Scaffolded support is specific in that it is used in the beginning of teaching to assist students to reach the above process, but later students depend on each other for the support to achieve the academic goals. From working together students are able to reflect and contribute as equal scholars. Through this reflection students are able to apply and develop skills for Critical Thinking through peer and community interactions and are able to approach a problem with the knowledge that there are others whom they can depend upon to contribute to a goal.

In *Development of Bicultural Identity,* Holcomb states that "all parents and educators of deaf children realize the potential harmful effect should they deny their deaf child access to the Deaf community and Deaf culture. It is also critical for these parents and educators to realize that once the deaf individual's self-theory allows that individual to seek positive reactions to his or her deafness, that person will be better able to develop a bicultural identity and form healthy relationships with deaf and hearing people alike"(Holcomb, 1997, pp. 45). Holcomb shows us that in supporting students' interactions with all communities they can become members of the larger community

where they interact in positive and healthy ways outside the classroom community. In knowing and understanding their own knowledge and skills, students can explore relationships outside the classroom with a mindset of collaborative work. This collaborative work continues the development of self-identity where students understand their place in their own communities as learners of academic content, but also as contributors and scholars

Furthermore, the bilingual approach in the delivery of curricula is to be inclusive of all academic levels and capacities, allowing for students to explore their own misconceptions about their academic experiences and possibly other shortfalls that the educational system has emphasized. In "Appreciating Diversity through stories about the lives of Deaf people of Color", Anderson (2004) claims that, of the stories told, "many of the stories were about encountering obstacles to educational opportunities. These obstacles were not solely related to the experience of being Deaf."(pp. 75) Often obstacles come in the form of people imposing or making decisions, either historically or currently about their educational experiences, especially when students are Deaf. By becoming an active participant in their community, both the classroom and the societal community, students can challenge the accepted ideas and stigmas of unequal opportunity and rise above them. In this regard, the empowerment of knowing where they stand and who they are as individuals with experience and perspective will allow them to contribute to their own communities and those other communities they will be coming in contact with, linguistically, academically and socially.

III. Evidence of Need

In general, it is acknowledged in the field of Deaf education that the experiences of different individuals within the function of the Deaf education system vary based on socio-cultural, familial, and institutional experiences. These ideals are cited in the Education world as approaches that may support students in the attainment of higher levels of education. It has been noted that a bilingual, residential school, and early ASL exposure input is a marked "guarantee" of success for the students because the possibility of "develop[ing] a solid identity as deaf persons during this crucial period….will form a solid self-theory that enabled them to have healthy, realistic expectations of hearing people and deaf peers."(Holcomb, 1997, pg. 90). In light of this identity development, often underdeveloped literacy skills and, with that, academic language fluency prevents the full academic success of students. In a changing world where Common Core State Standards (CCSS) aim to include a large portion of standardized testing to reflect full English language proficiency as a marker of educational success, we must give the tools to Deaf students in a scaffolded manner to achieve proficient levels of both languages and to discern the differences between them as a method of reaching their educational goals.

In observations of different classrooms for the Deaf during student teaching, I found that classrooms for the Deaf often focus solely on reading and writing skills through curriculum that does not connect to other content areas. Often these stories, vocabulary, and supports do not connect and create cross content understanding of concepts. In this curriculum, the need is addressed through the continual exposure of common, interpersonal, and academic language in both ASL and English in an effort to move the students towards recognizing themselves as functions of a holistic experience.

In this experience, students engage in reading and writing in a way that is not tied to a specific time on a schedule set aside for only reading and writing. In contract, the curriculum I develop addresses an academic content in a way that is transferable to other areas including cooperative and collaborative learning through groups and peer to peer interactions.

To allow multiple perspectives to flourish in the classroom as a teacher, one must be able to acknowledge the differences in language fluency in both languages and understand that supports and groups must be balanced as a part of teaching where students not only try and understand each other in addition to the content at hand. Often competition within the classroom is seen as a motivating tool, however, students often find themselves pulling away from their peers, academically and socially. Thus, a hierarchy is formed in classrooms that creates an environment where the "smarter" students are "always right" and the "challenged" (or otherwise the labeled) students have an achievement gap compared to their hearing peers, where they are viewed as simply trying to reach for the higher achievement rather than being able to bring distinct knowledge of their own. When one creates a classroom where students find mutual respect for each other in the classroom, a learning community is formed in which relationships exist as mutual relationships rather than competitive relationships in which someone is always better than someone else. Holcomb (1997) described students with a sense of self as those who can form healthy expectations and relationships with peers and people outside of the community with whom they identify, and are able to grow as individuals who understand their own abilities and limitations. However, this is only possible when students are offered the opportunity to experience and explore their

communities as a holistic part of their identity development inside and outside the classroom. Thus, it is critical that inside the classroom students are supported in participating in an environment where content is explored and every person is a contributor.

IV. Review of Existing Curricula

Existing curricula in the area of science literacy for the Deaf is limited in its scope of bilingual literacy as a function of ASL and English. Currently, the curricula focus on the development of science literacy as a function of focusing on English. In *Making Science Accessible to Deaf Students*, McIntosh (1994) discusses how ASL makes science teaching very conceptual, but how the lack of connections to English often hinder the capacity of students to comprehend and gain fluency in science literacy. The researchers suggest that teachers are "leading them[students] to the supposedly "correct" destination, thereby limiting the students' opportunities to think and explore for themselves"(McIntosh, 1994 pg. 481).

McIntosh further comments that teachers often confuse procedural competence with cognitive ability in science. This extends the argument that literacy is a part of science and is a vital portion of the learning that can happen within the classroom. McIntosh continues by stating that the role of the teacher includes supporting the students through various modifications, the materials used and the activities as a part of the "determining factor for success"(1994). The main argument is that the curriculum that is successful for Deaf students is one in which all students have "well designed and flexible units" which include "discussion, debate, guided problem solving, analogies, pre-teaching and wrap up, hands on discovery…"(McIntosh, 1994, pp. 482).

The same author states that the "issue of science education for deaf students gained visibility around 1975, as the result of increased mainstreaming of deaf students". This was as a result of there being "little support or information on teaching science to

deaf students"(McIntosh, 1994 pp. 483). McIntosh reviewed science curriculum and found that three out of five concentrated and emphasized a content-based approach while the other two focused on a process-based approach.

It is the opinion of McIntosh (1994), that the process-based approach is more effective for Deaf classrooms. Historically, the nature of learning has been structured instructional time in Deaf classrooms. However, there is now evidence that Deaf students benefit from having "normal, unstructured play in which incidental learning occurs"(pp. 482). Having this unstructured play allows students to make self discovery with a guided approach as a method of process rather than a content approach where knowledge is front loaded for students in a structured lesson plan. This allows freedom and exploration for students to discover knowledge at their own pace and as a part of a process rather than a given piece of information. It is the recommendation of McIntosh that curriculum, both those that exist and future curricula, need to "capitalize on science as a context for reading, writing, and communication skills development"(pp. 483) (Lang, Engelston-Dodd, and Sachs 1983What is needed for the capitalization of science as a context for literacy is the coupling of a process approach to science education with the exploratory approach to science teaching, which seems to be most effective for Deaf students.

McIntosh (1994) states that "process-oriented teaching circumvents barriers imposed by English deficiencies by allowing teacher to focus on the academic subjects"(pg. 483) as a holistic part of the teaching. As mentioned above the process oriented approach allows students to self discover and experience where the language barriers directly related with English become less of an explicit lesson and more of a

support to the content that students are already experiencing as a part of the process. In addition, McIntosh(1994) states that "language learning that results in meaningful learning in the content area"(pg. 484), where the content area is therefore not a separate idea from the language learning that happens within that content area. The capacity for science to be a rich language experience as well as an academic learning area works in exposing students, not only to language they are comfortable using, but also to new vocabulary and language structures. McIntosh recommends that "teachers who use sign language in the classroom should become knowledgeable in the appropriate signs in science vocabulary"(pp. 485). McIntosh continues, "the future of science education of the deaf should look very similar to the future of science education for every other student" (1994 pg.484).

A more recent curriculum review is based on the success of the web as a portion of success in instructional science methods for the Deaf. In *Web-Based Science Instruction for Deaf Students: What Research Says to the Teacher*, Harry Lang and Donald Steely (2003) suggest that in the development of materials for use in the classroom the teacher must consider many student factors to drive the learning of science. These factors include reading ability, student engagement and "the need for visual reinforcement of the science content"(Lang and Steely 2003 pg. 275).

The researchers state that "verbatim captions of an audio message in a web-based course may not be enough to provide meaningful access to the information" and that "we assume that captions can enhance literacy in general" but in reality "studies indicate that....technology must be accompanied by a program of research and evaluation to

ensure optimal teaching and learning" (Lang and Steely 2003 pg. 279). This suggests that even with tools such as online research and the text based reading students can gain access to, curricula must be part of a plan to research and evaluate student work to support the full understanding of the material. Lang et al. further dictate that many successful designs in science and technology which incorporate graphic organizers and visual organization and examples in their curriculum, allow Deaf students further access to the material. "If students master the content and understand the relationships contained in the graphic organizers, they will have a good grasp of the basic core content"(Lang et al., 2003, pg. 287), meaning that when students understand the connections between graphic organizers and the overall content students will understand that the visual representation of the information is a source of support in understanding the content. Many of the curriculum designs discussed by Lang et al. (2003) used graphic organizers in conjunction with other media to successfully introduce students to the science content.

Thus, Deaf students succeed in science as a content area where they are allowed to explore and experience the content with support through literacy. In addition, students with support in literacy, especially the access through the internet and other computer based media where ASL is used as a bridge between academic functions of language used in English and ASL expression attain more engagement and retain more of a grasp on the concepts presented.

V. Key Learning Theories

The main learning features of my curriculum are based in the understanding that every student in the classroom will be an active participant through the use of the curriculum. Through full participation every student brings knowledge and understanding of concepts throughout the learning segments and is able to engage with and understand the other participants of the classroom. There are three learning theories that I will focus on: Critical Thinking, funds of knowledge, and cooperative learning. These features are ones that work in tandem with each other in a way that allows students to grow as a class and as individuals throughout the curriculum. The aim is that students take their own internal growth as critical thinkers through new and already known knowledge (funds of knowledge) and use these skills to achieve understanding of concepts as groups of peers through each individual contributing to the end goal of the project. Funds of knowledge, as defined by Gonzalez . (1994) in *Teacher Research on Funds of Knowledge: Learning from Households,* is a set of knowledge students have from their homes and communities when they arrive with at the classroom. This is discussed at length below. By starting as individuals, students reflect and understand their position within the group which allows for the development of Critical Thinking.

Critical Thinking is a theory which is an umbrella term in regards to the development of reasonable and reflective thinking and learning that is aimed at deciding what to believe or what to do. Critical Thinking is portrayed as a skill, in and of itself, that is an invaluable resource for any student to have. The skill of Critical Thinking allows people to recognize and evaluate information they are presented with to come to a

conclusion. It also allows people who work in teams to evaluate options, opinions, and facts from multiple perspectives, giving rise to such things as compromise, agreement and taking directions and stances on measures to be taken by the group (Glaser, 1941). This method of thinking is used to decide whether a claim is always true, sometimes true, partly true, or false (Mulnix, 2012). It is an aspect of my curriculum that I will aim to address through the student/teacher led discussions about different scientific concepts that can be observed and tested. In this regard, student exposure to an exploratory scientific process in which they participate as active members of the classroom community will be used as a springboard for the ideas of presenting multiple perspectives; their own or other historical ideas about a science concept. For example, the ideas and discussion of the three Newtonian laws of motion as a concept that can be observed and proven or cannot be tested and taken as laws simply because someone else has said that they define all motion. By exploring the scientific concepts on their own, students can learn to analyze both the facts given to them and their own scientific perspectives with first-hand experience.

The main focus of the theory of funds of knowledge is to debunk the assumption often made by the educational institution where students that come from linguistically and culturally diverse backgrounds do not enter the classroom with enough social and intellectual resources to succeed in the classroom (González, 1994). Students do, in fact, come with ideas and knowledge about the world to the classroom where intellectual gains can be made using this background knowledge and experience. Funds of knowledge within the Deaf community are transmitted differently than those of other culturally

diverse communities where cultural transmission is done through families. Funds of knowledge are also transmitted through hearing families with Deaf students and Deaf families with Deaf students. The focus of the funds of knowledge discussed here are those created as a classroom community. Out of several types of funds of knowledge discussed within the theory of funds of knowledge, cultural funds are ones pertaining to the social context a person participates in. These cultural funds are constructed as part of the Deaf community engagement done on the part of the Deaf individuals themselves where exposure is an important part of not only establishing self, but establishing knowledge as a community (Holcomb, 1997).

In this manner, my curriculum will focus on having students access and analyze a historical perspective about the experiences of different communities intersecting with their own. As a part of this, because funds of knowledge refers to historically developed and accumulated strategies (e.g., skills, abilities, ideas, practices) or bodies of knowledge that are essential to a household's functioning and well-being (Greenberg, 1989), the curriculum will work largely within peer to peer relationships where students gain knowledge from each other where the "household" in this case will be the classroom setting. Thus, the funds of knowledge will be built not as a household, but as a classroom. This is, however, with the acknowledgement that students will build upon the funds of knowledge brought with them from their true households as well, as defined by the theory of funds of knowledge. The bodies of knowledge are to serve a cooperative purpose within the classroom where students explore their own knowledge, new understandings, and roles within a particular working group parallel to that of the whole

class academic content knowledge they will acquire through group projects and whole classroom discussions.

The group project ideas have students reflect and share in groups, individually on paper, and as part of a cooperative classroom setting allowing for students to have an individual opinion on process and exploration of an academic concept as well as a collective understanding of each others' perspectives on learning, language, and interactions with this concept. For example, the continual understanding of a physics law or rule through writing, expression in ASL, and visual representations through experimentation would all be experienced individually and as a cooperative group where debate on how to document and describe the process occurs. Of particular interest for this curriculum design is the idea that students themselves express their roles as equals in the classroom rather than as competitors. Students work together to achieve not only knowledge, but understanding of what each individual brings to the group.

The theory cooperative learning, a research theory by Johnson and Johnson (1989) is a process of learning that happens when students work together to achieve learning goals shared among the group. Cooperative learning is something that is achievable when all students reach the same academic goal and they must accomplish this together. In the classroom this approach creates a classroom community where tasks are structured to give interdependence to students through group interactions that reach a particular academic goal (Sharan, 2010). The methods of cooperative learning allows for tasks in the curriculum to reach the goals of Critical Thinking by allowing students to interact with a collective funds of knowledge together from multiple perspectives.

Through this process students will be building two collective funds of knowledge: personal and scientific academic content knowledge. Through peer interdependence students will empower other students to communicate and build a collective goal as a classroom community where the goal is to learn from each other and build knowledge together through a project. Sharan (2010) discusses relationship interdependence as something that carries over to relationships outside the school, the communication and social interaction done through cooperative learning. The goals of cooperative learning are designed to promote this mutual assistance and support among group members, not only to accomplish the tasks given, as discussed above, but also to allow thinking beyond the self to include opinions, division of labor, and mutually inclusive tasks. Sharan continues that as classrooms continue to grow more diverse, cooperative learning allows multiple perspectives to be expressed because of the flexibility of the idea where students can contribute to the same goal in varied ways. Thus, the goal of these tasks to collectively analyze and reflect on personal experiences throughout the curriculum is aimed at creating discourse in the classroom regarding self identification. In this regard, the collective reflection of the group on individual knowledge will build Critical Thinking. In addition, the collective group task of building a historical perspective will allow for students to gain knowledge of their own experiences in the way in which identity and Deaf culture is constructed by both the other (Hearing) and themselves (Deaf).

VI. Curriculum Outline

This curriculum is designed to guide students through scientific processes pertaining to experimental design and implementations in the classroom. Students are also guided through a series of translations and transcriptions between ASL and English using video feedback. Throughout the process students collect pieces of a full scientific paper from initial concepts and research to conclusions and in person presentation of their written work.

The curriculum is based on California content standards for science and Common Core State Standards for Math. The California content standards cover the scientific process in addition to content specific guidelines. This is the reason they were chosen and why they were used to guide the curriculum. The curriculum was implemented in Washington, but all standards either overlapped or covered a wider range of topics than the Washington standards. The Common Core standards were used for the Mathematics portion and they were adopted by both California and Washington.

The guides assist the teacher in exposing students to several different types of example paragraphs and sentences to include in the written work. In addition, the curriculum includes graphic organizers to assist students in visualizing different thinking processes to set up and conduct experimentation in a science classroom.

There are modifications for each lesson to support advanced students and students who require more explicit practice or support. These modifications are intended to be integrated in the preceding lesson as add on challenges or guidance so that students at every level can access learning science concepts through self exploration and discovery.

The supporting documents include rubrics, descriptions, and sample procedures that align with physics standards to make a well-rounded unit with teacher background knowledge. These supporting documents can be found in the appendix section where the detailed curriculum in depicted in a step by step manner through three Units: A, B, and C. Unit A focuses on the preparatory work and debate on an initial concept or idea. The second section, Unit B focuses on the execution and analysis of data collected by students. The third and final section, Unit C is a walkthrough on creating and synthesizing units A and B into a written report with a presentation aspect where students dictate to others the process and final conclusions of their exploratory findings.

VII. Evaluation Plan

The evaluation plan for my curriculum will include the rubrics for each unit. The unit rubrics include both an individual portion and a group assessment. Overall, the students are to build the project through collecting knowledge in various formats, including graphic organizers, worksheets, and video throughout each unit and produce written results of each section. Students are graded on productivity and/or completion of the tasks and on their modifications/improvement of their work for each English and ASL section prepared as part of the final project. Student final projects are evaluated on their ability to express and explain, in both ASL and English, their process for experimentation as well as their own thoughts, reflections, and ideas from the process. Projects are read by peers who were not active participants within a particular project and, therefore, are unfamiliar with the content and procedure of the process taken by the project group. Peer and self assessment play a large role in improving and deepening explanations about the projects. Students use rubrics as a method for self and group work at the end of each unit.

The curriculum was evaluated using a reflective writing process to achieve a readable high school grade level science paper, which is the end result of the project. The rubrics are designed to support the evaluation of the curriculum relay on evaluating changes between the "rough" drafts of writing to the "final draft ready" writing that will to be included in the final paper as the conclusion of the project. Each student, as part of their self and group evaluation, evaluate themselves as a member of the group, evaluate the whole group, and evaluate whether or not they individually or the group were able to prove or understand their scientific concepts. Field notes were used to document student

and teacher challenges in understanding or executing the lesson plans. Exit slips were also used as a form of evaluation on the lessons at about the middle point of each unit. The exit slips ensured that the curriculum was making an impact on student understanding and if reteaching or changes in the curriculum were necessary. The final method of evaluating the curriculum was a pre- and post-writing sample using a "final rubric" to determine the student progress and the effectiveness of the curriculum.

VIII. Curriculum Implementation

Description of Timeline and Educational Context

Curriculum was started on April 18, 2013 and was completed on May 30, 2013 with the turning in of the final report. The implementation was able to be completed for two out of the three units in full and a modification (in which an example was given at the beginning of what would have been the third unit) was given and explained as time allowed during the concurrent completion of the report itself.

Overview of the School

The school is a Deaf residential institution that has a bilingual approach to teaching students. Students can live on the campus from age 5 until age 22. There is an elementary school program, a middle school program, a high school program, and a post high school program. The number of students in a class ranges from 4 to 9, depending on the class type and approach. In general, students are grouped by language/reading skills and age group. Students follow a series of academic milestones through IEPs (Individualized Education Plans)focused around Math and reading/language arts. The middle and high schools follows a schedule of 50 minute periods, Monday through Thursday, in the academic areas of Math, Reading, Language Arts (English/ASL blocks), History/Social Studies, Art, Science, and Health/PE in which the students rotate to each class on each of these days. On Friday the schedule differs and includes WAC, which is a session in a Weekly Leadership Activity in the morning, and in the afternoon there alternates every week either a “Class Meeting” for the high school and “Leadership Skills” for middle school, or an assembly for a special event such as the 500 Book kick

off, the Spelling Bee, Science Fair. Students are dismissed at noon on this day for transportation to their hometowns.

The general school schedule for each of the academic content areas varied depending on the type of class that was taking place. For science and math, the classes were conducted as 50 minute periods that include a 10-20 minute presentation of material, 10-20 minutes of collaborative group or individual work, and a 10-20 minute closure session. This is the typical schedule of most single periods of academic work at the school site. Some classes have "blocks" which can range from 140 minutes to four hours which are either joint English/ASL-Social Studies periods or just English/ASL periods. There was generally only one classroom teacher with each group of students with one on one aides that come in to work with certain students to support their learning.

Physical Environment and Learning Environment

The Divine School building is an indoor school that houses the middle and high schools. It is a square building with a square courtyard in the center. There are the immediate classrooms facing the courtyard that extend around the entire building, followed by a hallway and the outside classrooms facing the outside of the building. The classroom I worked in is in one of the corners not facing the courtyard. It was a small classroom that has a SmartBoard, a table with a sink, and a side table with an overhead projector connected to a Mac for teacher use. Directly on the other side of that wall, there was a white board cabinet and the main teacher desk with a class pet (snake). On the opposite of that side wall was a small set of computers for student use; this wall also houses the "intern desk." In the middle was a semi circle of 8 student desks.

The laboratory environment that we used during the implementation is a long rectangular room with access to the middle courtyard. It has blacktop tabletops, one teacher island with a blacktop at the front of the room with access to a SmartBoard, a white board and an adjacent small table. The rest of the blacktop tables are in a U shape facing the front teacher blacktop. All of these tables have a sink and cabinets under extending the length of the tables. There is a row of cabinets attached to the wall running the length of the entire room on one side of blacktop with additional cabinets. There was access to a storage room with access to a variety of beakers, test tubes, and additional chemistry materials including chemicals and various supplemental plastic and glassware for experimentation. Under the cabinets there is a wide range of various materials with which to conduct a variety of experiments, from supplemental materials such as test tube holders and clamps to items with which to conduct experiments including colored glass and triangular prism to different types of pulleys.

Description of Students and Classes

Table 1

Student per Education Period, Amount of Students and Descriptions of Individuals/Classes

	Students	Description
Period One	5 Students, 2 D 2 HH, All Deaf Self-Identified	Physics Class. Grade levels range from freshman to senior students. This class has the student who has the highest reading level in the high school. This class contains two students who are classified as Hard of Hearing and use both sign and speech freely to communicate. In addition, one of the students in this class has a low reading level but is very motivated to graduate.
Period Four	7 Students all D, All Deaf Self-Identified	Physics class, grade level, this class has the top academic students in the school, all students are at or above grade level reading/language levels with similar, but below grade writing levels. Grade levels are Sophomore to Seniors.
Period Five	6 students, all D, All Deaf Self-Identified	Physics class, below grade level. This class has students who are between slightly below to far below grade level comprehension, reading/writing/language. Some students in this class have been identified as Deaf+, as in they are Deaf but also have another learning or physical disability that is a challenge in receptive academic skills.

In a more detailed, narrative format the classes are described, and referred from here on out as:

1) First Period Class

2) Fourth Period Class

3) Fifth Period Class (Modified Class/Group)

1) The First Period Class is a smaller group of students, only four, of which there are two fully Deaf and two classified as Hard of Hearing and use sign in the academic settings of the classroom. One of the Deaf students has the highest reading level of the school and the other has a lower reading level of around the second grade. These reading levels were assessed by the ASL/English team at the school. All students are considered fluent in ASL by the ASL/English team. The Hard of Hearing students both have a mid-range reading level, between 6th and 8th grade respectively. There was a student who did not like math or science and made this point known repeatedly. This student did not see the value in taking these classes when her life goal was to become a writer. Another student liked science, but has never had the confidence to do well in the classroom. Additionally, this student struggled with keeping up with work and staying on task. The third student was motivated in finishing her work, as she hoped to be the first in her family to graduate from high school, worked hard despite coming from a background in which she says it may be easier to simply go back to not completing work and get passed along in school. The last student of this group struggled with confidence in an academic setting because he failed in the mainstream setting and was placed at the school for the Deaf. This class had two sophomores, one junior and one senior student.

2) The Fourth Period Class had one of the highest academic level students at the school. Several students were at or above grade level in this group and applied to be mainstreamed part time in the next academic year. There are three students who believed they had a deep understanding of the subject matter already and were very "right answer" oriented. These students were very resistant to cooperative work or to discussion of material. The other students in the class were slightly below grade level, but not far below it. They struggled more with the reading and writing aspects of the content than with the actual conceptual ideas themselves. The students were very capable of explaining and understanding the concepts but struggled with explaining their thinking in written form. This class was all sophomores.

3) The Fifth Period Class (Modified Class/Group)contained a group of students which was identified as the "modified" group. These students were far below grade level in reading and writing but not so far below that they needed to have a separate curriculum. The students were assessed in the same manner as the other students at the school. These students simply had a different pace and required more scaffolding and differentiated instruction to reach the same content as the other two classes. Some of these students were Deaf +. Deaf + or Deaf++ students have additional learning struggles such as ADHD, language delays, receptive and expressive language disorders, or other types of conditions that make academic learning challenging. Deaf + is defined here as Deaf with an additional disability such as ADHD or severe language receptive or expressive delays, but with the cognitive capacity to, with modification, achieve the same level of academic achievement as Deaf peers. (Whereas, with students who are Deaf ++,

modifications are necessary, but often the students are Deaf and have multiple disabilities that hinder achievement at the same level as peers and curriculum is often greatly modified to focus on functional skills as opposed to a strictly academic plan.) The students described here were Deaf +, Is it ++ or just 1 plus. If these are two different descriptors you need to describe the differences with added ++the former of the described. The students were very motivated to learn and were eager to access the material. Often, because of their challenges, some students had a good deal of self doubt and anxiety about completing work and/or whether or not they would pass their classes. This period had an aide who is, technically, assigned to one particular student. This student was transitioning from having a one-on-one support to being more independent and no longer requiring the one to one support. Thus, the aide played a general role of support in the classroom. This class contained two freshman and four sophomores.

Implementation

The implementation for all of the classes began with an honest anecdote from myself to the class about my role and the program expectations as well as that we would be working together as much as possible to gain understanding through my new lessons. The lessons were introduced as a new method of teaching where students would be responsible for teaching each other and deciding what they wanted to learn about. I gave a brief overview of what the lessons would look like, that there would be expectations of groups working together and how this would be used as an evaluation for their grades.

The structure of each lesson was the same for each class in the entire curriculum except for the summarized lessons toward the end of implementation. At the beginning of

each new lesson description, I gave a description of the lesson. The descriptions of student reactions, details in teaching struggles and changes were made period by period after the general overview of the lesson. Evidence in the form of "screen caps" of lessons via a SmartBoard, pictures and scanned student work were included with descriptions in these beginning overviews or within the period by period lesson notes.

Lesson One, Unit A 4/18/13.

This lesson began with an introduction of the Goals for the period/lesson.

This lesson had three goals:

1. We were to pick a topic
2. Brainstorm individual and group hypothesis
3. Begin researching via the book/internet.

Students were then led to the introduction of a hypothesis. We discussed what a hypothesis was and how it was used in the scientific process. All students either came up to the board after "think, pair, shares" to write their answers to the introductory questions about what a hypothesis and how it is used as the opening questions in order to explore a science concept as part of the scientific process. I wrote the answers reported by the students:

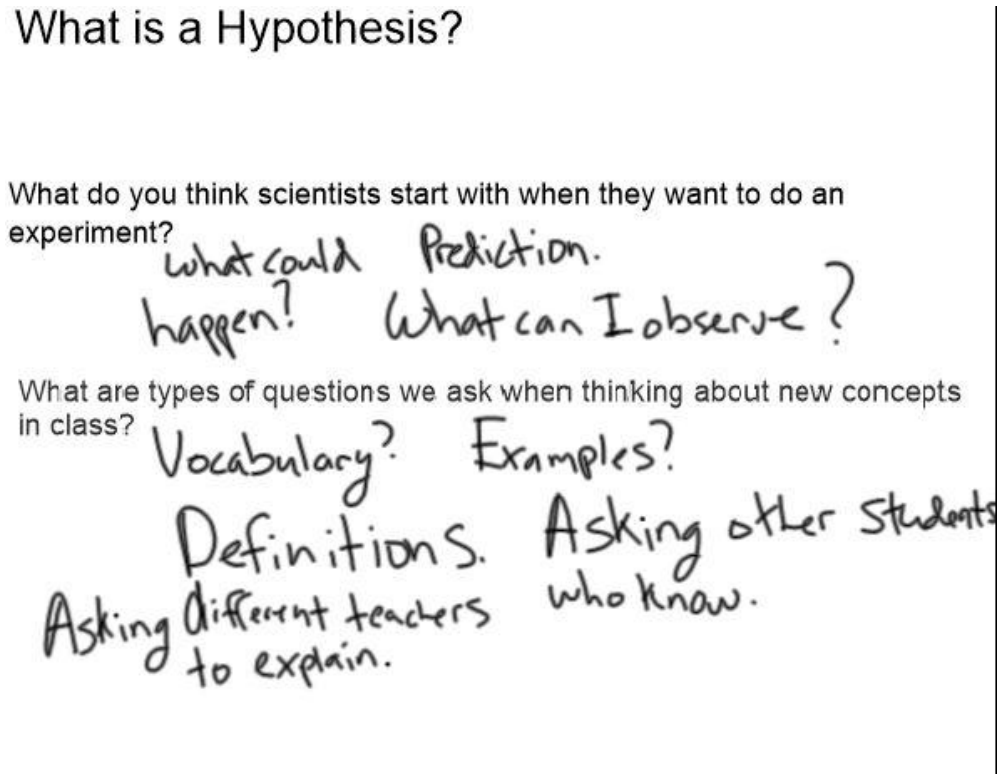

Figure 1 Screen capture of introductory questions with student answers about hypothesis. The students appeared to have an understanding with guidance of opening questions. The responses show a correct model of thinking of the types of questions and information pertaining to a hypothesis.

After the conclusion of this discussion, any student could add information not already written on the board. In the next portion of the lesson, I directed students to three different examples of hypotheses. These examples were to serve as guides to create differently worded (from simple to complex) hypothesis that would fit their eventual topic. I read and explained each level of hypothesis and asked students what they noticed. Students discussed and explained that they noticed similarities in explanation between the hypotheses. Students correctly identified that each hypothesis had supporting text about a scientific wondering and this was highlighted on the board.

The topics came next in the lesson. At this time the students were grouped into teacher selected small groups of between 2-4 students for the First and Fourth periods. With the modified lessons group (Fifth Period) our group and experimentation process was conducted as a whole class. Students moved into discussion, debate, and initial reading in their books about topics. I also answered questions about vocabulary they did not understand such as convection and conduction, both vocabulary that is used within the concept of heat. For all periods I directed students to refer to the Index of their textbook and modeled with a few words how to search and find the information and definition from the Index. After students came to a decision about their topic, they were asked to circle their topic and place their first initials by the topic, or in the case of the modified group (Period Five), we selected various topics then students read a little about them, I explained a little about each, then the class voted for a topic:

Figure 2 Student selections in Fourth Period Class in Lesson One of Implementation based on student lead discussions and decisions. Students used strategies including compromise, consensus and voting.

Figure 3 Modified student selections in Fifth Period Class in Lesson One of Implementation, in this class period students all voiced possible "favorites" or new concepts from the Index search that they were possibly interested in. Students showed each other the textbook and discussed which might be a good topic. The tallies show the voting process.

After topics were picked students were given individual and group hypothesis worksheets (Appendix B) and began researching their topic on the internet or through the book both individually and as small groups. Students began working independently depending on the context of if they were searching for information, and discussing as a group newly acquired information.

Period One.

In general, this group of students appeared to understand the idea of working together and individually, students negotiated amongst each other a division of work. For example, a pair of students negotiated that if one person read and explained, the other would be the scribe for the group. One student even asked if she could really not work individually, she did not want to be part of a group in which "other people would be responsible for [my] grade". She then attempted to pick her partner rather than being set in with a group with someone when I explained that the groups were preset based on my

observations of the class. They accepted the pre-formed groups easily after this discussion, the other two groups had witnessed this discussion and when prompted they said that they were willing to work together and didn't foresee any difficulty in completing a project together.

The groups or partners were as follows: H and S became partners because they appeared to get along and they lived in different cottages. Thus, they would have to coordinate discussing and communicating about homework. Y, N, and L were a group because L does not like science but Y does. N and L were at the same grade level and would motivate each other based on their friendship and my observations of the two of them interacting during whole group and small group discussions so far in the class. For example, L, who had a high reading level would often explain things to N, while N was more engaged with science as a content area and would push L to participate in class for her grade.

The picking of topics was uneventful, there was little discussion and most of the students gave into the majority through small negotiations. They picked topics successfully, either deciding on topics that were familiar to members of the group, or by searching the Index and picking a topic based on the figures in the book. Students within groups appeared flexible: when one student appeared passionate about a topic by elaborating or explaining the definition they would simply agree and not argue with their own, different topic.

The students appeared to struggle with the vocabulary on the worksheet for this lesson (Worksheet 1 Unit A Appendix B). They asked for clarification on the vocabulary

and how to complete the graphic organizer. In addition, group HS focused on playing related games on the internet as a form of exploration of their topic, “Simple Machines”. Group YLN did more reading of the research within the textbook and then moved to searching for figures on the internet about their topic, “Light”.

Period Four.

There was some hesitance in the beginning of the lesson because many of the students asked for more in-depth explanations about the opening questions. They appeared confused about the examples with the hypotheses and would ask about clarifying what I meant by the different levels of support that each had. I asked them to identify the question of each hypothesis, what the main portion of the hypothesis was. After underlining this portion I circled the remaining portion of the hypothesis and asked students to tell me what they noticed. Students were able to notice that the common factor for the three examples was that each had evidence to support the hypothesis.

When placed into groups they were as follows: The HAT group was picked because they have a friendship in that group and an additional highly science motivated individual. The KR group was picked because one student in the group is highly skilled and the other has unique approaches to solving problems, but doubts her own skills. The MJ group is the highest student and the “lowest” student in the group, this group was picked because one student will be tempted to do all the work, but it was a challenge that I felt both needed to approach learning from each other.

The picking of topics was contentious, the HAT group debated the most with one student even getting up from his seat to demonstrate a concept through an example by walking across the classroom to make his point about how simple the topic of "speed" was. Another student commented "This group is at War!" in regards to picking a topic. Another student of this group worked well at trying to get his topic picked through trying to reason with each of the other two. For this group, it came down to voting.

The MJ group just picked the topic that the top person wanted. The KR group debated a little, but also came down to the topic picked by the more motivated student. I instructed students to come to a decision in whatever way the group decided as a whole. While explaining the group selections I gave group expectations including instructions that each member of the group was an equal part of the group and that they would be held accountable as individuals as well as part of the small group.

The students moved into the research easily as it appeared to be familiar, but struggled with vocabulary pertaining to their topics, specifically with advanced descriptive terms when searching for definitions of their topics. After modeling the use of citing sources and giving them an example on the board, they did not know how to cite source information on the graphic organizer. I monitored the students and supported students individually, but I was not able to fully support all the students in a way that I felt was sufficient for us to move on into the next lesson. Upon reflection, I feel that a way to address this situation is to take a topic that no group has picked and doing a guided modeling where students search for opening information on a topic not tied to any

group to gather the process and feel for researching and citing appropriate information from various sources.

Period Five.

The lesson itself started out alright, then climaxed with the third opening question. The students really were connected and engaged in figuring out resources for themselves and asking others when they were in need of help understanding and learning new concepts. However, after this and even after explanations of each topic, students became disengaged. I felt this was because maybe they did not know many of these topics, and I should have modified the lesson further to give them less choices than I did with other groups. For example, I should have taken out all "Law" options from the list of topics that we could have possibly covered. In this way, students could see words they were more familiar with, or at least recognized to a certain extent.

I should have modified the graphic organizer because I came to realize quickly that in the computer lab, I lost the students. Students were either attempting to complete the objective but feeling overwhelmed by the information because of the high academic vocabulary and shutting down, or they were not attempting the research at all and were off task causing distractions to others in the class. I also did not provide enough room in the graphic organizer to support their expression of knowledge through drawings and the spaces too small for sentences and short word descriptions. In addition, I should have broken up the first lesson into two lessons for modification. The first part of the broken up lesson should focus on the same topics we were able to achieve understanding on during the first part of the lesson. These included: background knowledge, topic

selection, and what research looks like. The second part of the broken up lesson would focus on supporting these students in searching for, documenting, and using evidence for writing a cohesive hypothesis. In contrast to the other groups the movement from background to hypothesis examples, back to background and research, did not flow as well for the students in this classroom. I should have broken this lesson up into two as described above, focusing on the two aspects as connected by separate actions. I would add a mini-lesson to write the hypothesis itself after the two separate lessons as an add-on support instead of a full lesson because it would be a connecting idea to the larger lesson and would focus on just the conventions of expressing a hypothesis.

The students in this period appeared to gain nothing from the independent work after the introductory lesson that was planned. In addition, although I had worked with these students for a little over a month at the time of the implementation, I had not planned to incorporate or to modify the lessons for this group because through the lessons up until my implementation students appeared to only have difficulties in specific academic areas such as writing full procedure in mathematics, or explaining in ASL a concept then being able to write out the same concept on paper rather than procedurally or socially. From the perspective of my mentor teacher and I, the students were not getting what they needed from my lesson and required more modification. This would mean that everything should have been modeled and done together as a group rather than through the independence in a more ‘I do, we do’ process than the modeling done for the other two groups where it would be ‘I do then you do.’ It became clear to me very quickly during the independent part of the lesson that students would require more

support as a whole group and were not going to be able to function as separate independent groups as students became disjointed and forgot what other students had said or supported in the whole group discussion and students were unable to apply these thoughts into their own continued work after the break up of the whole group. Thus, I planned for the next lessons to use my sections on modifications for extra support which is included in my lesson plans and would focus on supporting students to support each other as a larger group with I as a facilitator rather than the students being both a participate and a facilitator. This was used to shift the focus from the students juggling both knowledge about peer to peer support independently and new content knowledge to just the exploratory science content. In this way, students would be able to focus on working together instead of becoming overwhelmed with negotiating roles as a whole group.

Overall feedback from an observer (my CT) said that he agreed that, as a whole group, we should explore this process rather than split into groups due to the huge range of language reception and expression skills in this classroom, students were not grouped in this class period to begin with, but when moved to a more independent practice students were not able to support each other as they did effectively when in the whole group setting.

Lesson One/Two, Unit A 4/22/13.

This lesson began with a re-teaching/review of Lesson One with more support in the aspect of researching and writing down information about the topic. I then moved from the review of their answers and ideas from the first lesson attempt. Students became

more engaged as they were able to connect the review material to the worksheets. In addition, students were able to create initial hypotheses from this review that previously had not been successful because of the lesson structure. The lesson structure had two separate objectives and some students who were not able to complete the second objective of creating a hypothesis were able to in this re-teaching. In re-teaching the lesson, I made explicit connections to how the graphic organizer was to support the student's thinking when creating a hypothesis. I also left the example hypothesis on the board for the students to refer to while they researched. This reference to the hypothesis (now hypothesis on the white board) added to the success of the reteaching. After this portion of the re-teach in period one and four we moved to the second lesson that included writing the finalized hypotheses on the board for the groups. In the modified group, period five, we created two final hypotheses from class discussion then students voted on the final group one:

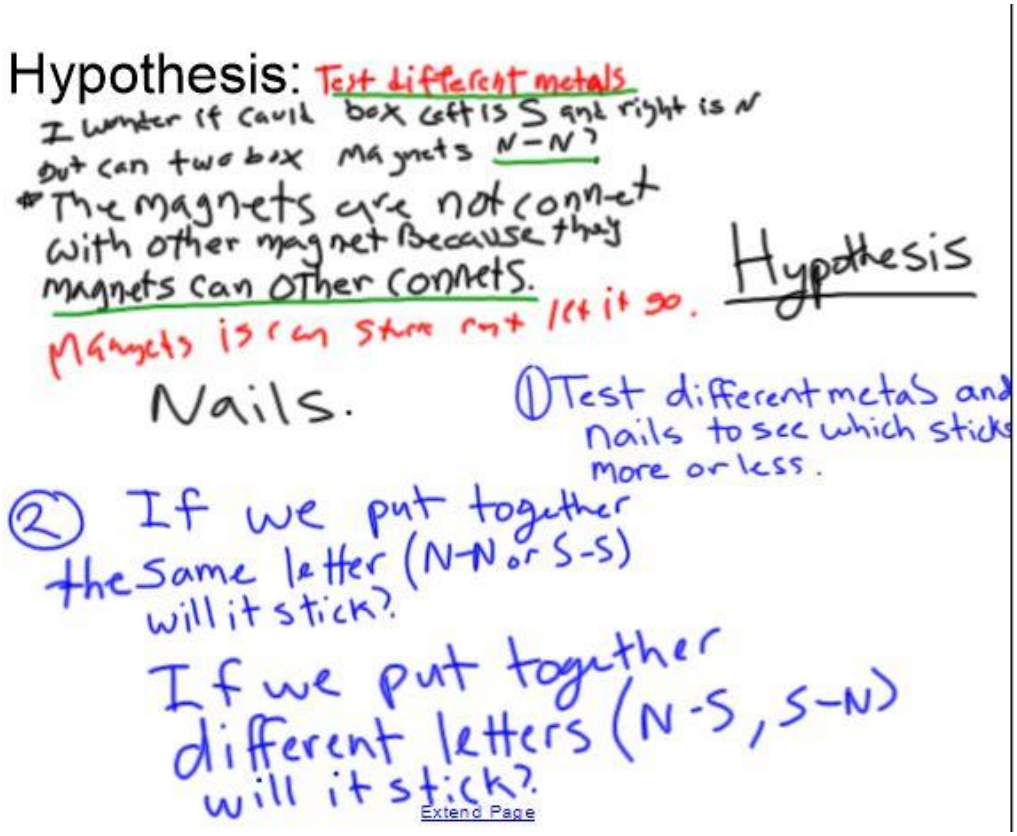

Figure 4 Modified Lesson Two, Period Five Group discussion notes/Final two Hypotheses. This hypothesis was constructed as a whole class. The voting finalized number 1 as the official group hypothesis and we planned our experiment using this hypothesis.

For periods one and four students wrote their final hypothesis on the board and followed the partner/small group script (Unit A Lesson Two) to modify and change their final hypothesis if necessary. These hypotheses were made within the working groups and thus there were anywhere from two to three different topics/hypotheses per class:

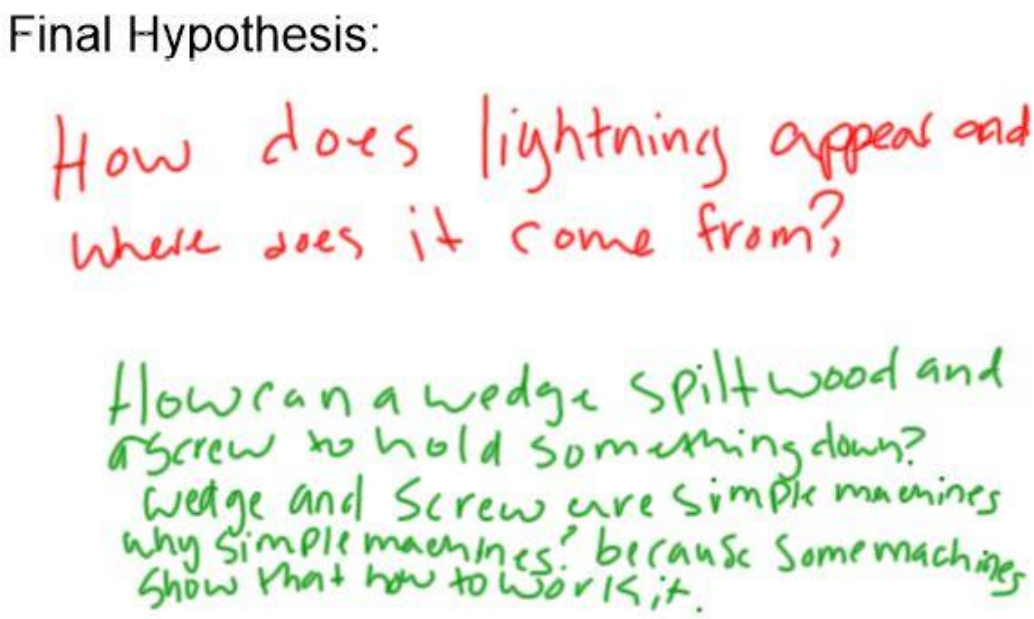

Figure 5 Lesson Two, Period one groups HS and YL final hypothesis after modifications suggested by peers. Group YL added "where does it come from?" after a discussion on what they were looking for in "How does lightning appear?". Group HS was asked by another group what a wedge and screw was, thus adding the sentence following the question supporting their thoughts.

Period One.

Today for the Period One class I re-taught the first lesson and had the students finish their individual and group brainstorming sheets. Students H and S decided that doing a project on simple machines would be the best choice and chose to do a project on a screw and a wedge. I had discussed with them that there are many different kinds of simple machines and that they would be wise to focus on two or three different ones rather than all 8 of the machines listed in the book.

Group YLN was dropped to just YL as the third group person transferred to another school. Today this group negotiated their topic. Y very strongly wanted to do the topic of color and L was very strongly inclined to do the topic of lightning and how it works. After a lively discussion in which each explained points of why they should each pick the other's topic, I suggested possibly finding something that they both could compromise on. In this context, the students found in the book that the making of rainbows from light and producing color was an interesting topic and restructured their brainstorming pages to "Light". Students completed the worksheets in both individual and group brainstorming.

The re-teaching of the material appeared to be successful, as mentioned above; students were able to complete the graphic organizers and complete a hypothesis where, before the re-teaching, students were unsure of what kind of information to add to the graphic organizer. I also explained that after negotiation with my mentor teacher and the principal that we would be focusing on my curriculum for two straight weeks to make sure that students understood and felt supported in completing the work in a manner that would be timely and easily connected throughout the Units. As it stood before this discussion with my mentor teacher, the students would only work on their projects twice a week, where connections and discussions could be lost without consistent exposure to the expectations and being able to turn around a lesson with more in depth re-teaching the next day. The change in schedule would also allow me to see and document progress more easily because students would be constantly immersed in discussions and I would be able to see progress or lack thereof in a timely manner to address and redirect my

teaching. The students were eager to continue the work after completing the worksheets, but were asked to hold off on giving each other feedback to allow other students to catch up.

Period Four.

In this class, the group HAT continued to debate their topic and were the first to finish their worksheets and discussions. The KR group was second to finish giving feedback and completing worksheets and discussions within the first 15 minutes of class. They were set to build a motor, and R of the group was confident in producing this kind of model as opposed to an experiment. I explained to him, as I had yesterday, that we were limited by what is in the laboratory at the school. He and I argued as to the validity of my statement, and I explained that it was "part of the rules" and "not fair to other students who didn't have other things to add to their project from home". I also suggested that R could do motors as part of R's science project (an outside extracurricular project). R wanted to know who made the rules, and I responded that I did. I made this move in terms of the limitations of my curriculum, where if students were allowed to bring in outside materials from home it would nullify the basis of the curriculum where students can be creative and resourceful thinkers with the materials at any given school site. The argument in addition to allowing students to become more creative within given parameters of a laboratory setting, as often true scientists must be, I felt that in allowing a student with access to resources not given in the lab to bring in a pre-made model of an engine from home would limit the goals of the curriculum. For example, a pre-made model did not allow the student to think critically about how to present or build the

engine himself. In addition, the student would cut the participation of others in the group because there would be no cooperative exploration of creating an experiment or negotiating the use of equipment to showcase their concept. The Group MJ struggled with continued lack of communication among the members of the group; J of the group still held fast to the fact at there was an "individual" portion of the experiment that he wanted to complete on his own before moving on to the "group" portion. The M of the group would ask me what he was to do if his group mate would not cooperate. I told him to complete his own work and to try his best to cooperate because it was part of their grade. The scripts for feedback in some of the lessons were supports for getting students to talk to each other about their project. In addition, opening questions and think-small group-shares were used as a method for student interaction.

As a whole, because most students finished or were very near completion of their hypothesis, we moved on to the second lesson that was already prepared. I loaded the script for student feedback (Unit A Lesson Two for the second lesson I modeled the script and what they should say. I timed students from different groups explaining their hypothesis. However, students still appeared to struggle with the concept of following a script. I had to go up to each group pair and explain again. Students also said that they did not understand the point of doing this exercise of explaining their hypothesis in order to teach each other. There were students, specifically group HAT that made changes to their hypothesis based on feedback from the MJ group that explained that they should put down more information to aid understanding of what they meant because from the initial

reading, group MJ did not understand what the HAT group meant to say in their hypothesis.

Period Five.

These students were able to complete more research that focused on the physical science book. I told students to draw their research rather than writing sentences, which worked out better for almost all the students because students were able to express their thoughts without the anxiety of needing to produce a sentence in English but were given the opportunity to put down their thoughts in a different way. Students appeared more confident in figuring out how to find information on our topic, "Magnets", and were also very confident in sharing with each other as to where to find information and discuss it. Students were able to come up with three different hypotheses that we explained to each other. Students were then asked to pick one that they personally would attempt to defend and discover. I wrote the hypothesis on the board and signed back what students wanted to report. The students were provided an opportunity to provide feedback on how to improve the writing. Students seemed very successful in this aspect and we completed the period with successful student research as opposed to the week before in which most students were not able to complete or understand the point of researching and complete hypothesis writing and selection.

Lesson Two/Three, Unit A 4/23/13.

This lesson began with the review of the final hypotheses we had concluded on the previous day. The students were introduced to the concept of translating their ideas

from the sample hypotheses in the first lesson. I would translate the hypothesis into ASL from the English and explain to the students that it would not be a direct translation word for word. I asked them to think about how the two languages were different but still connected. Students appeared familiar with this concept and were able to explain to me that this process was a common practice for their ASL/English class. This enabled us to move quickly into feedback and translation. The students were also easily able to film themselves individually about their hypothesis. Each class was able to give feedback and incorporated it into their final videos.

During fourth period, we moved to Lesson Three. I began the lesson with a short review of what kinds of variables they might encounter within their projects. When students appeared to struggle with the idea I tried to move to simple examples of comparison between two different objects, one which behaves the way you expect it to, and how you can change one to observe the differences. Afterwards, the students appeared to respond better to this idea of variables and how to apply them to their experiments rather than simply their hypothesis. Students completed the following worksheet after this expansion on the definition and usage of variables:

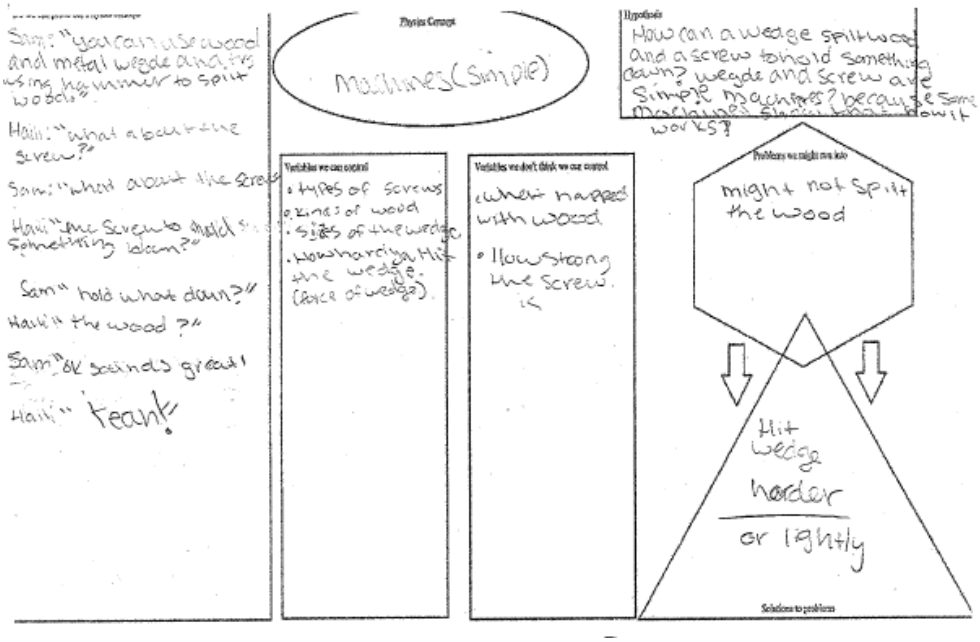

Figure 6 Variables planning worksheet, period One, This worksheet was completed successfully although students had difficulty understanding the concept of variables after the completion of their hypothesis. They also did not yet have a full visualization for their experiment at this point in the process and I felt that this stopped a lot of students from understanding varied parts within the process.

Period One.

Students in this period were able to complete the script. Students made changes and agreed to improve on their explanations of their concepts and what they knew so far. Student L exclaimed that "I know nothing yet!" about their topic and continued to speak

toward the lack of understanding of how it all connected. I directed student L to speak to student Y about what she thought they knew so far. Student Y, part of L's group, had a better grasp of understanding where the goals of the project was going and tried to calm down student L who was exclaiming the lack of understanding. Student L enjoyed having creative freedom to write whatever he/she wanted as opposed to trying to fit within the sentence frames given. With this creative freedom, student L was able to understand the goals of the project. This class, because they were a smaller group of students, finished role-playing quickly and we moved on the next lesson which was the filming their presentation of the hypothesis. I had students take their written work and film themselves presenting their hypothesis individually or their group hypothesis. Students were the ones to bring up that we needed a background "like the one we have in Tyler's [the ASL/English teacher] class". Not fully understanding what they meant, my mentor teacher went to grab a blue screen on a rolling support frame. This is something that I needed to add into my explanations of filming procedure for the third lesson. The addition of a background that was blue and neutral helped to hide the activity of the classroom. I continued to do one on one support with the students to improve and apply the feedback from other students and to get a clearer picture of the signs within the video. Students also were able to watch the other hypotheses, not as a whole class but by watching the other videos on the computer where they filmed them. I had difficulties transferring the video to another source and therefore was not able to have students watch as a whole class and give feedback.

Period Four.

In this period students filmed their hypothesis and I also did lesson four of my curriculum. Students appeared to be vaguely familiar with the ideas of controls, independent and dependent variables and diligently wrote down notes during the introductory lecture. Students appeared to struggle with the understanding of how these variables applied to a later procedure. I feel that I should reorder my lessons in which the planning of the procedure would come first and the variables would come second. The students made comments such as “I don’t understand the variables”, “How does this relate to the hypothesis", and “I don’t understand, not clear” in regards to the variables and how they apply in experimentation. I attempted to redirect conversations back to the task at hand, the discussion about variables within the experiment. Students were attempting to focus on the hypothesis which they had already completed and did not see the variables as a new concept. I did not have much success in attempting to redirect the students back to the discussion on variables or in trying to re-teach the lesson and refer back to the examples of variables in a sample experiment (Unit A Lesson Three) This lesson wasn’t as successful as the other ones up to this point. Students were all able to film their hypothesis on the computer and I felt that this at least was successful as we had talked about scripting and feedback as part of the modifications and feedback from the previous lesson.

Period Five.

In this lesson, the students discussed in pairs their hypothesis from the previous lesson about how to translate the written English hypothesis to ASL. After this, I asked each student to come to the front and sign their hypothesis. Students then waited at the

front while the rest of the group gave feedback as to how to improve their signs in front of the camera. Students gave feedback such as “Go slower”, “Sign more clearly”, “That’s too English, more ASL”(with examples of how to change it), “Keep your eyes forward”, “Don’t look down”, and “Have more confidence, because you can!” Students were very supportive of each other. It was very exciting to see the students supporting each other. After a student was finished receiving feedback, they would sign it again incorporating the suggested changes and a few additional modifications. Afterwards, the student would go to individually film their hypothesis and the next student would come up to sign their hypothesis. I felt that this modification process is something that I need to change in the curriculum itself, in the modification section of Lesson Three. Students who found it challenging to express their thoughts through written English could express themselves more easily through film. . At the end of this process, we briefly went over the fourth lesson, control and variables, but did not go as in depth as with other class periods. I skimmed this lesson because we were continuing to do this project as a group. I felt I would have control over how much time we spent as a class on this subject. In addition, I felt that with this particular period the modifications indicated at the end of every lesson in the curriculum lessons were supporting the students. The students were able to understand the process as a whole and give input to their project as opposed to focusing strictly on understanding details in their report process.

Lesson Four/Five, Unit A 4/24/13.

This lesson started out slightly different than the original lesson in the curriculum. I began with a discussion on safety and equipment use. The initial questions raised ideas

about laboratory procedure and appropriate use of equipment. Additionally, the students asked why there was a need to know what kinds of materials they would be using for the procedure. Ideas of how they would incorporate their hypothesis into their own thoughts about the experiment procedure:

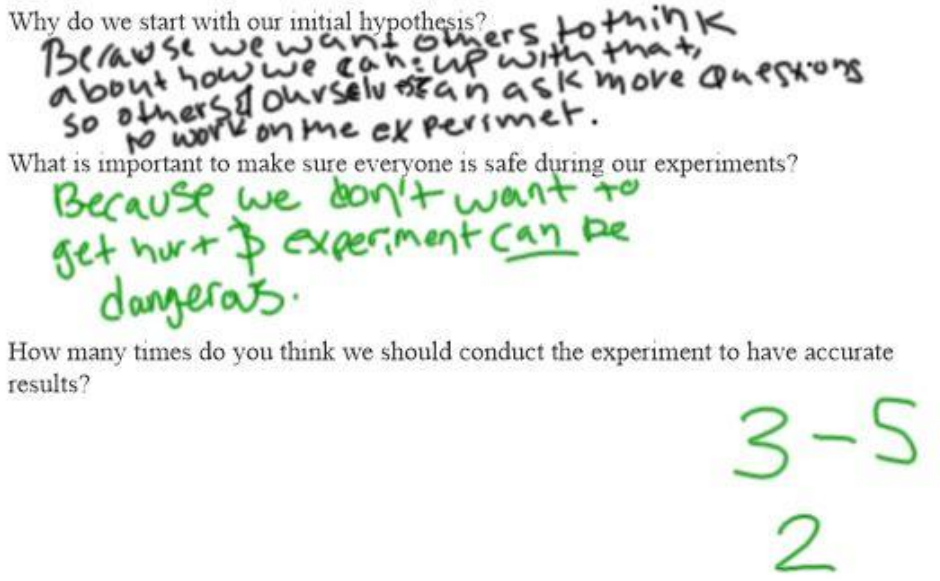

Figure 7 Procedure questions and ideas about safety, Period Four Lesson Four/Five. This figure shows student responses to the important issue of safety within the laboratory setting and about how we must repeat experimentation to fully understand and observe what is happening instead of observing only once.

From here students were asked to explore the different items in the laboratory that were set out:

Figure 8 All possible lab equipment was set out here on this table with printed out labels stating each item's name. Students were to write down on the procedure worksheet what they needed and the quantity to assist in their procedure (see figure 9). From this, students worked to begin planning their procedure.

Names
Date: 4/29/13
Period: 4th

Physics Concept
Insulators & Conductors

	Material Name	How Many?
1	Battery (6 volts)	1-2
2	Light bulb	2
3	Wires	4
4	Wool	1
5	Wood (Thin & flat)	1
6	Switch	1
7	Switch board	1
8		
9		
10		
11		
12		
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Figure 9 Materials Worksheet, Period Four Group AT

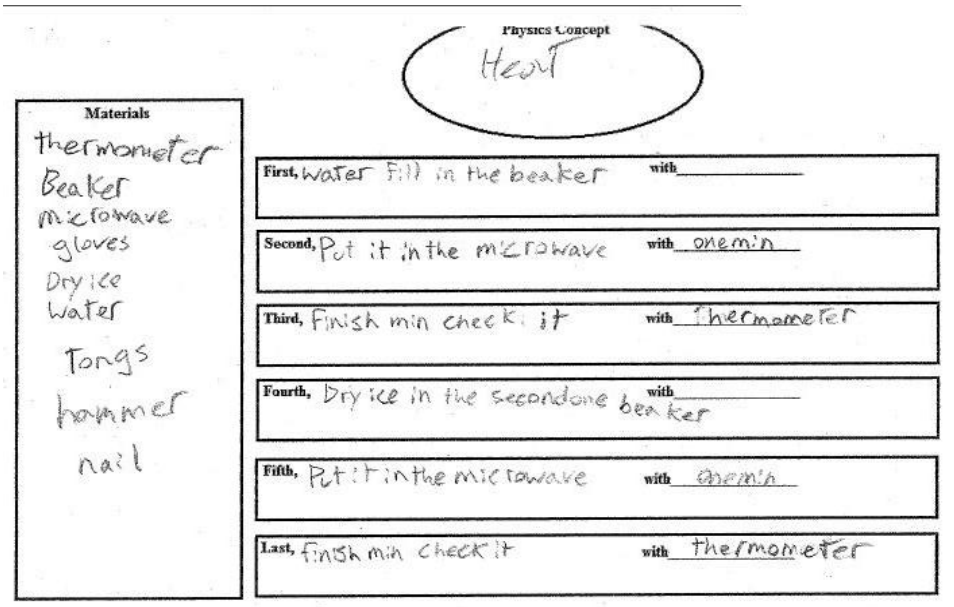


Figure 10 Planning Procedure Worksheet, Period Four Group MR This worksheet was used by all groups to organize thoughts on what steps to take to complete the experiments.

The modified group (Period Five) was also taken through this process, but we brainstormed ideas of things we could test before entering the laboratory and to check availability of items. Students wanted to test a range of items from hair to Cochlear implants. While the former was an easy item to obtain, the latter required me to direct the students to the fact that we could not test people in this experiment. Additionally they would have to ask if such equipment, not in current use by a person would be available for testing from the Audiologist. This appeared to satisfy students, and we moved to

creating our list of possible ideas in conjunction with the book and the examples the book had for testable items (including metal fillings). Upon the conclusion of this, we went to the lab and checked the list to the items available to us to make a final test list.

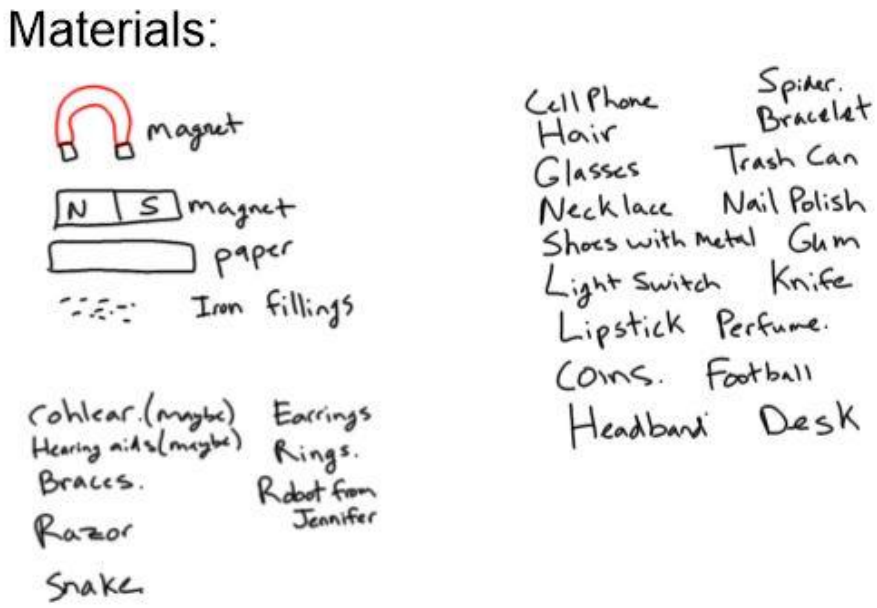


Figure 11 Proposed Material list, Period Five. This figure shows the student's ideas of what kinds of objects they felt curious in knowing whether or not they were magnetic.

Period One.

In this class the students were able to complete their initial procedure. They seemed curious about how to pick items that were laid out and explored, as they should have, what items might be relevant to their project. The lecture of the lesson was changed to explaining each item "live" in the laboratory and explaining uses as we went through each item. Students in group YL continually wondered how it might be relevant to their project about light. I explained that they needed to select items that were in fact relevant

to their topic, and essentially ignore other items that they did not need. This group was very good about collaborating and making changes to their list and how to use it, they took turns and added suggestions from each person in the group about what possible things would be needed in their experiment. From this item list, I had students go back to their procedure and add items as well as "as much detail as possible" for "others to understand your procedure." The students continued to try and just write things as they understood them and we ran out of time. Students were able to understand and were ready for the next day in which their procedure would be "carried out" by another group.

Period Four.

In this class, it was a struggle to get students to focus and pay attention to the task at hand. Students had been off task and I had to talk to them about expectations. We had a discussion and students felt frustrated at the concept of the projects being so open ended that they felt that there was a lack of direction and support. I addressed this by talking to the students about how this process was more about self discovery than about reaching a correct answer, that this was the foundation of the project in addition to learning how to work together and teach each other. Students had trouble planning their items and discussing what they needed as a group even though we had that conversation about how to plan and select items. Many students strayed off task as I moved from group to group trying to be supportive and help give students more direction about what they needed to do. The KR group decided to change their entire project and move from doing "Motors" to doing "Magnets" because of the lack of resources in the laboratory to build a model motor. Additionally, the conversation from the previous day in which it was explained

that materials at home would not be permitted influenced their decision to change to magnets. This group went back and recompleted, re-filmed, and re-wrote their hypothesis, their procedure, and their discussions about their project. I felt that this was a successful rerouting and re-planning of their experiment because it often happens within real experimentation in a science laboratory that one needs to change one's topic because of a lack of resources. I pointed this out to the rest of the class and explained that this is a true limitation in actual laboratories and how this project was open-ended so that they themselves could explore the scientific process.

Period Five.

In this period the modification to making the procedure was flipped. We first made a running list of what we wanted to "test" (as was the final group hypothesis that we voted on) to see if they were able to stick to a magnet or not. The students made a very long list that included Cochlear implants and the class pet, but were very invested in knowing and understanding the limits of our list. The students and I then went to the lab and they tried to find what they could find from the list. They re-wrote the list to reflect things that they had access to in the lab. After this period, I went to talk to the audiologist who agreed to let us borrow several "sample" hearing aids and cochlear implants so that we could test them for our experiments. The students in the next lesson were going to conduct their experiment that they had agreed upon, then they would write it down.

Lesson Five/Six, Unit A 4/25/13.

In this lesson I began with students exchanging procedures and discussing the sentences they had completed for homework as their "final" procedure. Students came in with written or printed procedures that were to be conducted as their experiments. Students followed a similar script to the modification of their hypothesis in this exchange. After this feedback, we moved to the laboratory and, with their exchanged procedures, attempted to set up and conduct the experiments from the other groups. Students quickly realized that there was not enough detail or steps to actually do their experiments. This was a theme among all the classes. After this attempt, I moved students to discuss with each other about how to improve their procedures. Students rewrote their procedures and then changed and altered them to be clear as can be seen in Figure 12.

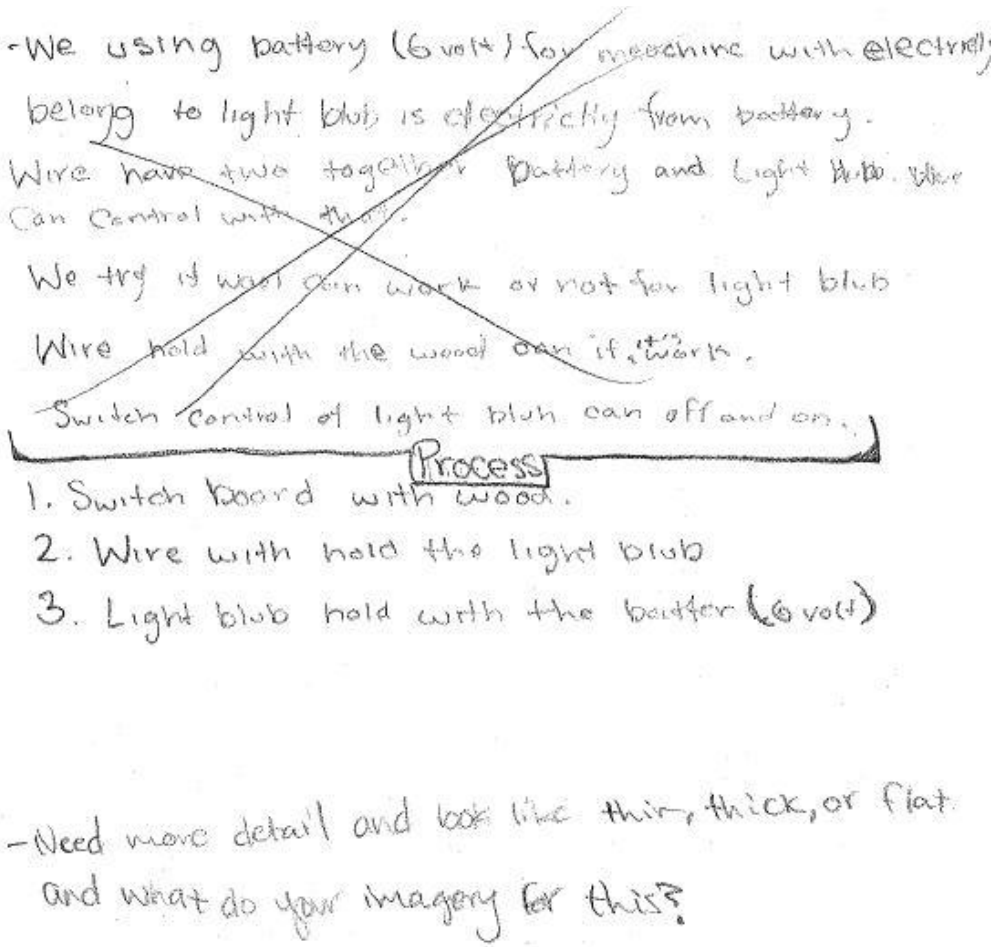


Figure 12 Student Procedure with modifications including other group written feedback about how to improve steps.

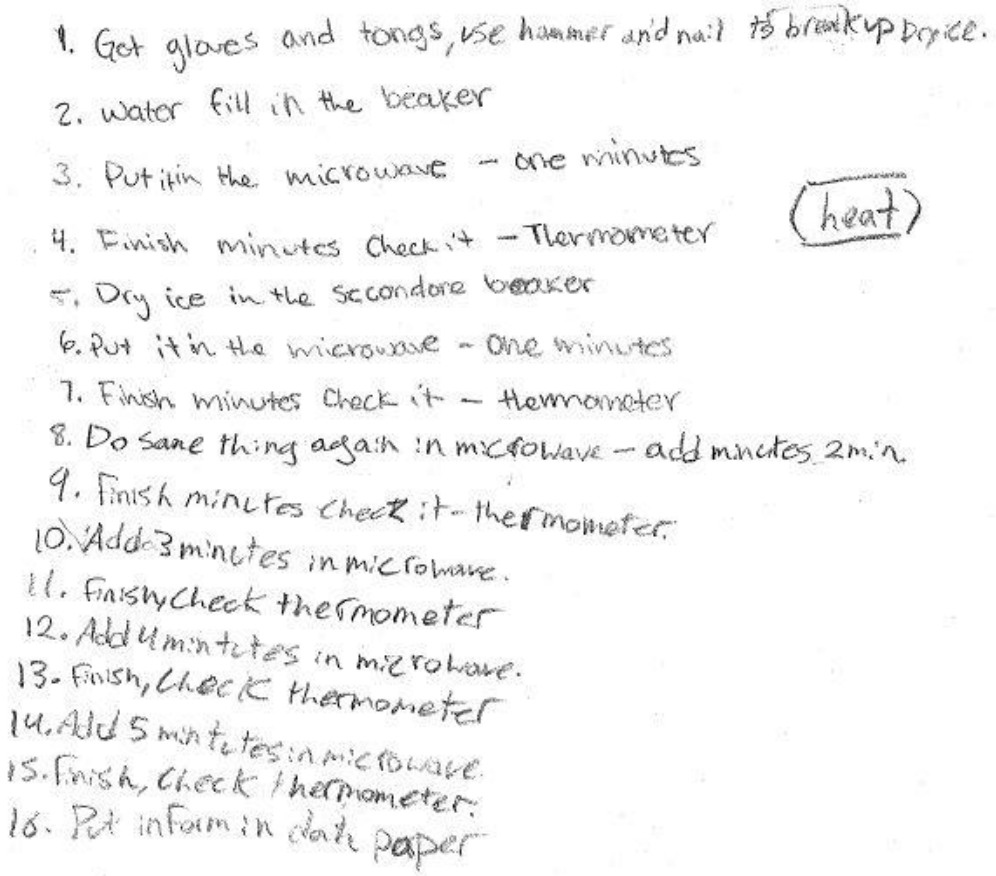


Figure 13 Proposed final procedure from modifications, re-written with more steps and in depth explanation of steps.

In Fifth Period we came up with a standard procedure, then implemented it. Upon return, we compared results about which items the magnets stuck to or not. We put up the numbers of tallies each person had for a "yes" or a "no" magnet sticking:

Figure 14. Two different individual student results in Fifth period that were compared. Students used the same table and recorded their observations about the same objects but came up with wildly different answers. The table on the left side has far more "no did not stick" recorded than the table on the right. This became the spring board for a discussion on how to improve procedure.

The results in figure 14 were not similar and, in fact, varied wildly while students followed a general procedure with not set steps or conclusions. Upon return to the classroom we discussed how and why the class had such different results from each student. Students were able to reflect on how everyone differently interpreted the procedure and how the steps needed to be more clear. I directed the students to explain in depth what they did, how they did it, and what kinds of steps they felt would be clear to each other. We discussed the steps in ASL for each student to understand what was to happen then we transitioned to writing the procedure.

Period One.

In this period we had a lot of success. Students were asked to come in with their procedures from the previous day and exchange them as per the last part of Lesson Five. The students were then asked to try and carry out the experiments, instead of simply discussing their procedure as the lesson was originally written. This was because the students had already planned and visualized their experiment and after collectively designing a data collection sheet the students were ready to move on to performing the experiment. Students appeared lost and it became a time of laughter as students tried to follow the directions. The YL group tried to conduct the HS group's idea of testing a wedge and tried to hammer a screw into a piece of wood with little success. The HS group tried carrying out the YL group's procedure and ended up with less than the required wires and no actual light was processed. The students then turned to me and said "we don't get it", "this isn't clear enough" to which I responded, "Then you need to make it more clear and detailed for other people, right?" Students then recognized that further elaboration of their experimental procedures was needed and began collaborating on what they actually meant in their directions and edited their procedures. Students gave feedback and modeled what they had meant in the rough drafts of their procedure and decided how to script the actions to make a more clear procedure. The group HS decided to change their experiment completely at this point and chose to focus on pulleys as a simple machine rather than the wedge and screw. They felt that "we could measure it better" and "its not as complicated" as describing the wedge and screw procedure. They felt that "there was no point" to their previous procedure having seen it first hand in action with another group.

Period Four.

In this period students had a similar experience in which, during the modeled exchange of experiments, students had no idea what they were doing. Students in this period were less receptive to edits and changes, but made progress in understanding that others were to read and understand their experiments. The group MJ has made progress in working together and decided on an exact procedure which I felt was very detailed and could successfully be implemented. The group KR was still attempting to negotiate changes to their experiment and the group HAT was very frustrated with each other about their edits and changes. With more one on one help, students were able to complete this portion of the improvements. Students were warned that if they did not fully complete their experimental procedure to a level in which safety was key and where appropriate detail of the process was proposed, and would therefore be approved by me, then they would not be allowed to conduct their experiments.

Period Five.

Today in this period we conducted the experiment. The students retrieved items and tested them. Students were a bit haphazard and did not fully document some of their results. We did not have a standardized procedure and I did this as a modification to the last portion of lesson Five, where the students exchanged procedures for clarity. After our quick conduction of the experiment, we wrote on the board in the classroom our results. I asked students to tell me what they noticed about our numbers. There were comments such as “they’re all different”, “why do some people have less?”, “You had more!”, “They’re so different”, “there’s varied”. I asked them to think about why they might be

varied. The students responded with “because we weren’t paying attention”, “I didn’t finish”, and “we didn’t decide how stick, not stick”. We discussed how we could improve this for next time and I told them to decide a good number of times to “standardize” our experiment. We then wrote our procedure of what we did as a whole class. We took turns discussing what we did from the beginning of going into the lab to what we would do next with our standardized procedure). These modifications were very helpful to our group who understood the transition from ASL explanations to written from as opposed to the other way of translations from English to ASL (our hypothesis). It also helped a lot to have students reflect on their first experience and how we could improve it for the next time.

Lesson Six, Unit A/ Lesson One Unit B 4/29/13.

This lesson was a continuation of the previous lesson for Periods One and Four with modifications and improvements to their procedure to be conducted. In fifth period we re-conducted the new procedure the students had signed and written the day before.

Period One.

Before we conducted the experiments, students were required to show me a completed cleaned up procedure and to film their procedure before we could begin. On this day students caught up with their work and we were to start the experiments on the next day. This particular day we had shortened periods, due to an assembly, and so we were not yet ready to conduct our experiments.

Period Four.

Students were trying to collaborate on improving procedure but appeared stuck on how to expand on their previous work and the discussion from the week before. Students made good progress and support was given by me in expanding their thoughts. Time ran out during this period and many students did not finish their procedures, and it was assigned as homework.

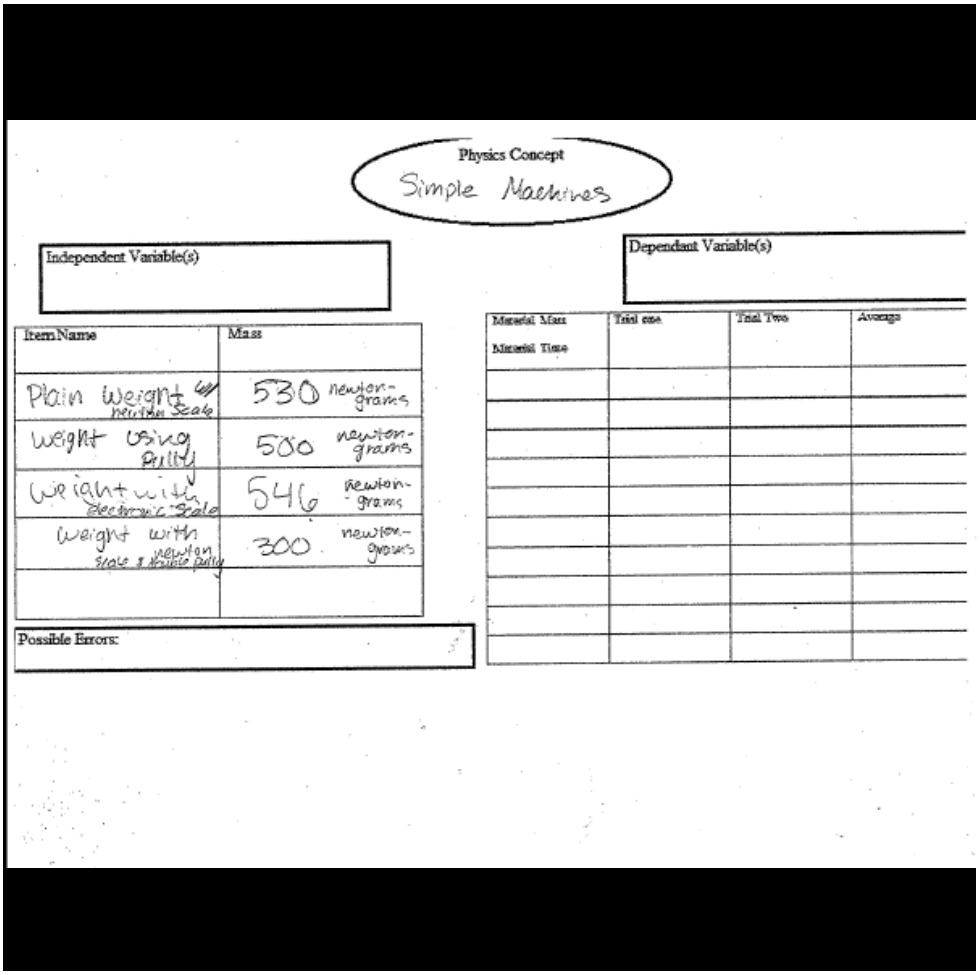
Period Five.

We conducted our experiment again and happened to finish right as our shortened period was ending. The students were excited to compare results the next day.

Lesson One, Unit B 4/30/13.

This lesson began with a brief review of expectations for the lab, students were to show and explain the procedures before we were to begin experimenting. The expectations included writing down information on either of two worksheets (Appendix

B) for what kind of data students may be putting down from their group:



Physics Concept

Simple Machines

Independent Variable(s)

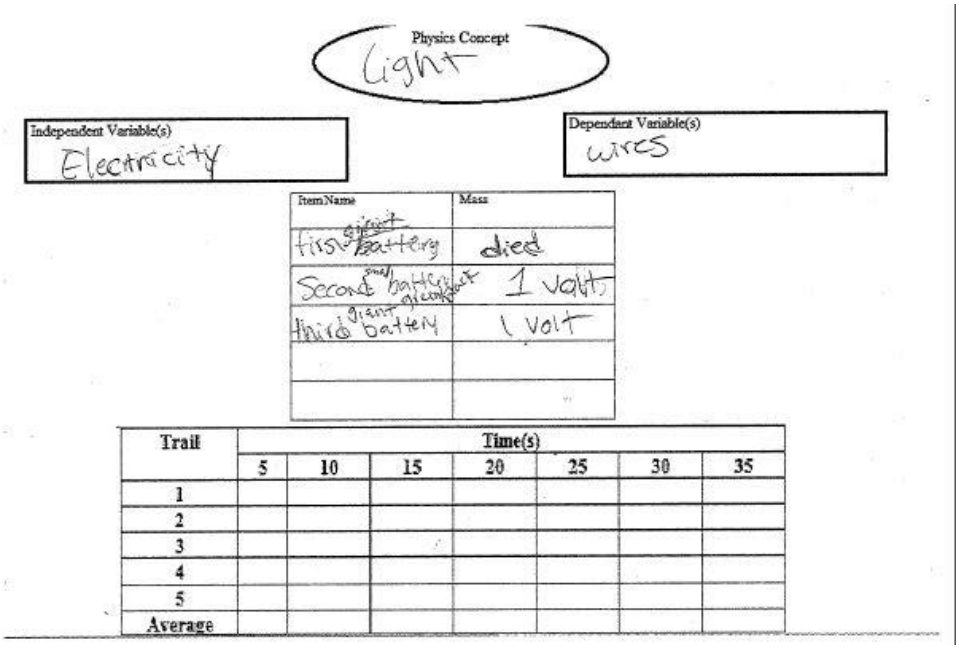
Dependant Variable(s)

Item Name	Mass
Plain Weight w/ Newton Scale	530 newton-grams
Weight using Pully	500 newton-grams
Weight with Electronic Scale	546 newton-grams
Weight with newton scale & double pully	300 newton-grams

Possible Errors:

Material Mass / Material Time	Trial one	Trial Two	Average

Figure 15 Data Collection Worksheet, students used it to record the mass of their object as work was being done using a pulley.



Physics Concept: Light

Independent Variable(s): Electricity

Dependant Variable(s): wires

Item Name	Mass
first giant battery	died
Second small battery giant	1 volt
third giant battery	1 volt

Trail	Time(s)						
	5	10	15	20	25	30	35
1							
2							
3							
4							
5							
Average							

Figure 16 Student data collection sheet. During this experiment students were measuring the brightness of a light using the voltage of different batteries. Students used in some or in whole part these worksheets to record data from experimentation. Students used the units that were familiar to them, either metric or standard units, or what happened to be present in the measurement of the experiment.

Students conducted experiments as per their procedures and were asked to observe and note changes, struggles, and errors as they went along. One example is in the above experiment of "light" in the first column it said "Dead" as the battery did not have any charge. I directed the students to note this instead of simply replacing the battery with explanation. I gave various students additional support in what kind of measurement

instruments to use along with their already set equipment lists for accurate data collection.

For the modified period, we filmed in detail our procedure. We discussed in what order we should sign the procedure, what the order of the students was, and how every students could improve their signing on film. After this videoing, we reviewed the different captures of procedure on film. When students were satisfied with the explanation, we called it a finished product. If they were not satisfied, then they would film it again. The students supported each other during this process including the suggested co-signing support (where one student would sign to the student to be filmed to help with struggles in memorization).

Period One.

We conducted experiments today. Students had to show me their procedures before we began and students were to choose between the two different samples of data recording sheets. Students were asked to modify, change, write in, or not write into the sheets as they saw fit for their experiments. Students were told that they did not need to fill in each section as in previous worksheets but were able to choose to write down whatever they wanted or needed. Students were also asked to complete the sentence/paragraph frames in a printed out sheet. The group YL had a couple of snags in their experiment when a battery appeared dead and when a light bulb died in the middle of their experiment. The group HS required more support in showing how the diagrams from the book worked in the real pulley system (students were not sure how to replicate the diagrams), and they also were given a Newton scale, with which to measure their

experiment force, which was previously not available (my mentor gave me one when I asked, as I could not find one to put out for the students). The students conducted their experiments a few times and tried to compare results.

Period Four.

Today we conducted experiments. Students were asked to show me procedures and to complete the printed out materials (paragraph frames) regarding how to measure the experiments they would be conducting. Before we even went into lab, because of the nature of one of the experiments using dry ice, I went over a set of expectations with the students regarding this experiment. First I spoke to the group itself that was using the dry ice about safety procedure and how they needed to keep that in mind when working with the dry ice. I spoke to the whole class about how they were not to approach the dry ice group and how they were to go around the "long way" to exit the room because of the placement of the dry ice and the other needs for that particular experiment group. During the experiments the group HAT was given a voltmeter to measure and test the conduction of their experimental set up. The group KR was given a stand up triangle prism ruler to measure the strength of their magnets. The MJ group, the dry ice group, handled their dry ice well. However, I had a couple of students from the HAT group that did not follow safety procedure and moved toward the MJ group. I had to have a strong talk, where I outlined the safety concerns and how they could really get hurt if they continued to neglect the rules and expectations we had discussed before experimentation. Students responded well to this talk and I had no further issues on this subject about lab safety. I feel that in the curriculum I should make more explicit a frontloading and pre-teaching

section specifically geared towards laboratory safety as a whole lesson. I added a few concepts here and there, especially to the procedure lesson where safety was discussed. However, I feel that changes to my curriculum, specifically a whole lesson on safety, would be beneficial for the students' to grasp a deeper understanding of the need for detailed procedure, explicit information and safety as a whole part of the scientific process.

Period Five.

In this period we compared our first experiment to our second experiment. We analyzed the results of the comparison and drew the conclusion that there were many things that had metal inside of them that stuck to the magnets. Some students spoke about things that appeared to have mental but did not stick. I explained that there are things that are metals that magnets do not stick to; that there are only specific metals that can stick to magnets. After this process, we repeated the ASL-English translation feedback session as with our hypothesis but took turns with each step in our procedure. The students supported each other and because of our previous experience with these students, they had more of an idea of how to work together and discuss the material. This process again worked very well in the expected lesson of filming our procedure and filming our partial results. The students helped each other in the filming this time. I was able to acquire a camera to use for this period and students filmed each other signing the procedure. There were several takes during which students gave additional feedback . This is something that needs to be written into my lessons as modifications and alternate order of lessons.

Lesson Two, Unit B 5/1/13.

The lesson was started with three quotes in which students were introduced to the idea of connecting their experimental data to math. I led students through the three quotes and had them discuss pictures following the quote and how they related to their own experiments:

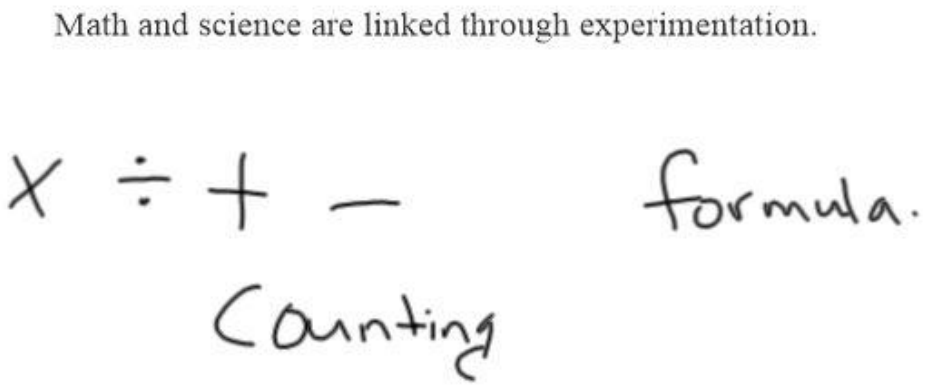


Figure 17 First Quote in Lesson Two, student responses to what they thought the quote meant.

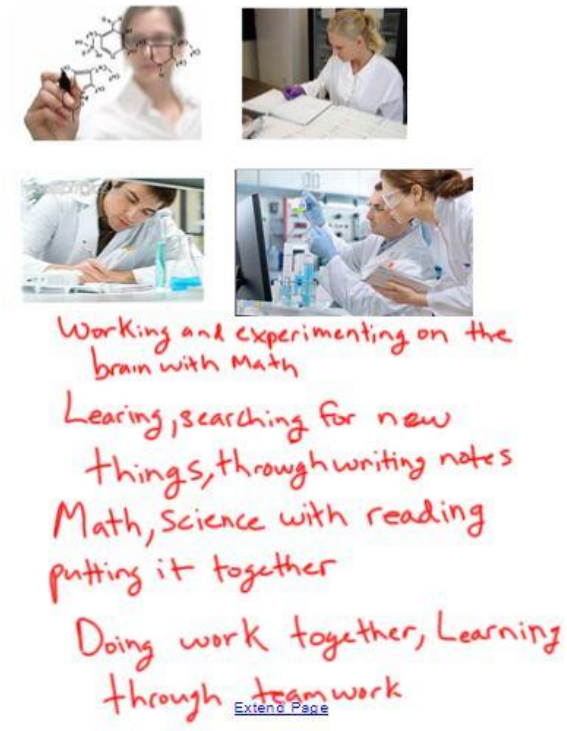


Figure 18 Pictures related to quote, and student responses on how they related to quote and how they related to their own experiences throughout the experimentation process.

Students did understand the first part with the quotes and the relationships that I was trying to convey between science and math. However, after the introductory lesson, for the independent part where students were given the Error Worksheet(in Appendix B) they did not understand how to use it. Students were given the following example:

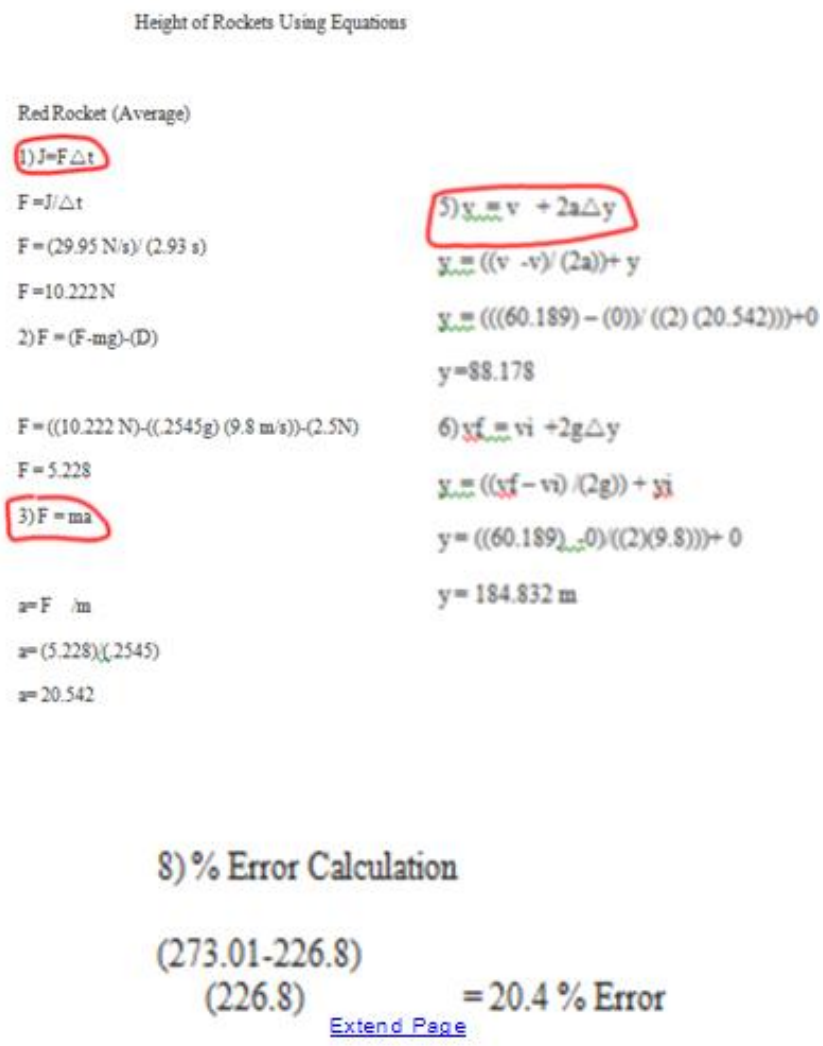


Figure 19 Example from lesson, students shown that equations, like the ones we had studied before my curriculum, could apply to their experiments and could therefore be calculated and compared to their own data they had collected.

Students struggled with the concept of relating their own data to that of an "ideal" which could be found mathematically. I decided to re-direct students by asking them to write down things that went wrong with their experiment. What were things that happened that were "off"? This was easy for them to expand on because I had asked them to take note of such things during the experimental process. Students began to approach this expansion and I explained that this had to be included into their report. If they felt

that they did not have a mathematical basis, they should explain what it should have looked like, then what actually happened and how it was different from their initial thoughts of the process.

Period One.

The prepared materials for this lesson appeared to not correlate very well with the goals of the lesson. Students appeared confused at the examples because they did not match their own data worksheets. The students also did not seem to understand the need for having an "ideal" and "experimental". In all, this lesson became irrelevant and inapplicable. I altered my curriculum for this lesson and tried to make things relevant to having students understand that this information was to be written into their report.

Period Four.

Similar to first period students struggled with understanding how this was relevant and did not understand the need for errors. Students ended up writing down things that "went wrong" during their experiments to improve on next time.

Period Five.

In this period we discussed how our data sheets mirrored the ones in the given examples and talked about how we can clean them up and how we compared them the previous day. Students wrote down each other's results and discussed among themselves their variation in data, but made comments such as "better", "less varied" and "more same" indicating an improvement in their procedure.

Lesson Three, Unit B 5/2/13.

This lesson was changed slightly to reflect not only graphs but also other graphic representations in the written report, based on the previous lesson where students did not appear to have a grasp nor the sufficient data to create graphs in Periods One and Four. The students were re-introduced to the guiding quotes in Lesson Two, "Math and science are linked through experimentation", "Mathematics is the foundation for proving or disproving many phenomena in the science world" and "Scientists try and prove their ideas with the time they observed something, what was the number of the phenomena observed, explanation through writing, and through proving with numbers facts." I asked them to think about what each meant, from here, students continued to work on trying to create graphs. (This applied to Period One and Period Four)

Period One.

Students did not understand how to create graphs from their data. For example, group YL did not have any numbered data and they were not sure what kinds of graphs to add or how to create them. In their small groups with my one on one support I explained that they could find out more information, additional research such as what light bulbs were made of and how electricity created light and add that to their report since they had seen it firsthand. The group HS also did not understand how they could find an "ideal" from the previous day to create a graph but were able to research and find a formula that helped them better grasp the concept. They were also not able to successfully make a graph.

Period Four.

Students in this period understood and were able to create drafts of some graphs. Students struggled with the need for graphic representation in their, at this point, hypothetical report but agreed to add different pictures to their work and began researching after the lecture on what these should look like.

Period Five.

This period was more successful in creating a graph. Based on the lecture, students decided as a class to create bar graphs based on the type of data they had. The discussion was short and unanimous about the graph type. I then allowed students to create their graphs and explained that this were "rough" and the also had to create "final" drafts that looked like the examples (colored, clear graphs with appropriate units on the axes).

Final Implementation Notes

The remaining lessons, Unit B Lesson Five through the end of the curriculum were combined and out of order because of time constraints in the month of May due to field trips, shortened implementation allowance, and absences. However, I have day by day notes and reflections from the rest of implementation. In the last three weeks of my implementation I was allowed two out of four academic days to implement my curriculum and I chose to summarize and do more individualized support from creating a final report example after an initial lesson on how to do the written report.

5/5/13

Students in periods one and four were given a copy of the paragraph frames from lesson five and walked through the initial finding of their experiment. Students were given an additional, not written in my curriculum, lesson about how to approach writing a report. It turned into a mini lesson on how to fill out sentence frames and how their own rough draft work they have been collecting since the beginning was to be used in conjunction with these sentence frames. I instructed student to come up to the board where I had projected the paragraph frames and asked them to fill in information regarding their experiment into them. Students then were asked to copy these into their own notes and discuss edits that they felt would be appropriate to make the sentences clearer. Students did not have a chance to film their initial results but had a discussion on what they had found out in ASL. From their error paragraphs and discussions students spoke to each other about how to fill out the paragraph frames as given by their group topics. The students made comments such as “it makes sense” and “I see” in regards to the continuity of the written reports.

Students in fifth period caught up on their final graphs and were given the additional Lesson Three, Unit B modification to support their understanding of the report process and the importance of their graphs.

5/6/13

I began this lesson by asking students to gather all their materials they had so far in their process from the beginning and review and add to their initial results paragraphs.

Students were also given the opportunity to do more research and were shown the paragraph frames from Lesson One, Unit C as a guide to needing to do more research and to fully explain their experimentation process. Students struggled with finding new additional information and explaining their thinking about how their experiments fit within that context. Students did not understand why a historical context was necessary and many students struggled with finding information online that was at their reading level to successfully do additional research.

Students in fifth period were also asked to gather all their materials from the beginning and to discuss what is next in our writing. They were not given the paragraph frames, but as a whole class we discussed what our graphs looked like and why they were different from the first experiment to the second experiment. Students also reviewed their comments from the Lesson Three, Unit B modification lesson and discussed how it applied to their own experimental process.

5/15/13

I started the lesson on this day checking in with students about their progress. I asked students to continue to work on their paragraphs and to review videos they had on procedure and hypothesis. Students were also asked to continue their progress on their written work. I helped support the groups and individuals who needed guidance on how to proceed with their writing and the format that was to be expected. Students continued work on their paragraph writing and they were asked to review their videos on procedure and hypothesis and to add to their final written works. Students worked independently and together on improving and creating drafts for their final report, of which an example

would be handed out the next day. Many students asked to review the rubric for grading again and students were allowed to continue doing research on their topic to complete introductory paragraphs.

Students in fifth period reviewed their videos and made comments in ASL about how they felt their signing was and how they could improve it. Students made sure that their written work matched their hypothesis and matched their procedure. As a class we discussed what we could do differently in terms of filming and students suggested that they would have liked to have also filmed our additional conversations on feedback to "help us remember to do our best".

5/16/13

On this day I gave the students the full example of what the report should look like (See Appendix B). I explained the expectations that were written on the front page of the report example and asked to begin working and adding all their information into the report. The students at this point had all of the raw materials to complete the report and had to fill in the paragraph/sentence frames as was modeled and practiced with the "Initial Findings" and "Introduction" paragraphs.

Fifth period students were given a similar report format, but it did not have the Introduction, Results, or Conclusion portions of the report as we were not going to have time to teach the full lessons because of end of the year activities.

5/22/13

Students continued to work on their reports, many student absences made it difficult for collaboration and discussion on conclusions and results work. Some students are very far behind in their writing and are not catching up during class time. Some students appear frustrated at the fact that "the other group person has it", in regards to papers, or information. Some students say that they cannot work because the other person knows what is going on.

5/23/13

This day was All Star Day at the school. Students continued to work on their writing, finalizing graphs, while I provided general help in completing the written assignment. This was a considerably shortened period because of All Star day, an open house/end of the year celebration with parents. Students continued to type up the report.

5/29/13

Students were given, on this final day, pictures from their experimentation and asked to include them in the report as the example dictated. I supported the fifth period students by posting the two pictures I had from their group experimentation on the board and we co-wrote the sentences to go under them for the students' present. I helped a few students after school from this period in creating their own sentences to explain the pictures to be included in their report. During Fifth period we concentrated on finishing and printing what the students had as well as collecting their final graphs and adding them to the report. (Example in Appendix C

IX. Evaluation

The curriculum was evaluated using a reflective writing process to achieve a readable high school grade level science paper which is the end result of the project. Field notes were used to document student and teacher challenges in understanding or executing the lesson plans. Exit slips were also used as a form of evaluation on the lessons at about the middle point of each unit. The exit slips ensured that the curriculum was making an impact on student understanding and if reteaching or changes in the curriculum were necessary. The final method of evaluating the curriculum was a pre and post writing sample using a “final rubric” to determine the student progress and the effectiveness of the curriculum. The discussion that follows will use these pieces of evidence to discuss each of the goals and how they were achieved in the implementation of the curriculum.

The first of the goals of the curriculum was "Creating and designing an experiment to showcase an idea, concept or thought of a scientific topic or concept." This goal was achieved in all groups, in which each group designed and implemented an experiment. Every small group--or in the case of the modified fifth period group, the whole group--wrote and performed a procedure to show their concept. There were six procedures that were conducted to showcase five different concepts. The concepts were light, simple machines, heat, electricity, and magnets. One notable group, which was able to create an experiment design that still achieved the goal of the curriculum to showcase an idea, was the group that did an investigation on light. The group originally had discussed attempting to showcase and figure out lightning. Absent of something to actually create electricity from the air, the students used a battery and a light to discuss

the filament and how that was a conductor for electricity. This group, although did not literally create electricity was able to explain how to create a set up in a series of steps and how it was important and that electricity was connected with lighting and the brightness of light. The most notable group, that achieved this goal of the curriculum, was the modified fifth period group. This group began with the idea of magnetism and initial prior knowledge about what they thought would be magnetic and decided a series of materials to test. From this first procedure run-through, the students reflected upon their data. The data was significantly different for each student, and as a group they discussed and added a step in the procedure to make it more effective and accurate. The students were driven to show a good example of magnetism and how there are items that, specifically, have metal but are not magnetic. These students were the most successful in reflecting and discussing how to improve their experiment to show a better example of the concept.

The second goal pertained to the written student work as part of the final project: the written report. The goal, to "Analyze and evaluate self and peer work as part of editing and improving writing as a process", relied heavily on student motivation to improve their own work for the final project. Students were able to show the most support for each other in different aspects of the project. Most notably, students appeared to improve and worked towards perfecting, more specifically, the hypothesis. This was the first portion of the scientific process presented during the curriculum and students spent the most amount of time working on the hypothesis through constantly revisiting the question and the evidence connected to the question. Through this revisit, students

were able to create very solid improvements through self and small group collaboration. Even though the single process of analysis happened with the hypothesis, overall the students were able to understand that changes were to be made between the worksheets and the final project. Through incremental changes in discussion and reflection, students were able to analyze and take steps between lessons to come back to the next lesson with a more clear written work. The best example of this was in the first period class, where a group of students took an idea with simple machines, scrapped the idea because they were not able to showcase it in the way that was clear and understandable, and re-wrote a new procedure/experiment with the same base information. These students understood that there were salvageable pieces within their drafts to create a new procedure and write a clearer procedure/experiment using different simple machines. Students in this group were also the ones with the most supporting evidence in their reports. The supporting evidence and expansion appears to have been taken from the analysis that these students did of themselves and that others were able to express to them about what was and was not. Although there was some evidence that this goal was met, I feel that the full extent of analysis the students were expected to make was not at the caliber of the goal and therefore this goal was not fully met.

The third goal was: "Discussion in peer groups regarding texts or topics related to scientific process and concepts." This statement was the basis for the core of the curriculum. Cooperative learning happens when all students work towards the same academic goal. Peer groups were the driving force behind the curriculum. The groups had to work together to achieve completion of worksheets, work from those sheets to create

expression of science process concepts in ASL and English, and produce a final individual project as a culmination of the entire group process. Discussion as pairs, small groups and during whole group feedback sessions was the foundation for students to improve on work or clarify thoughts and concepts. Students worked together to give feedback on various aspects of the process. Other than the scientific process points mentioned already, the one aspect that showed this goal the best was the discussion of the selection of materials for the procedure. Students debated among themselves what kinds of materials they would need for the procedure. In this debate, students made arguments for and against the materials and how they would best show the concept they chose. The choosing of materials is an important part of the scientific process, and was done on the basis of discussion and based on the science concepts the students wanted to showcase. This goal was met because of the constant communication students had throughout the project which facilitated the completion of all projects.

The final goal or the fourth goal was an important foundation of the curriculum: to "Improve or develop Critical Thinking skills through analysis of texts/discussions/peer sharing throughout the process." This was a focal point of each of the peer discussions students had. The most significant evidence of the achievement of this goal was during the execution of the rough draft of procedures in each group. After a run through of another group’s procedure, students (through laughter and puzzlement) had critical discussions about having different perspectives on what the procedures looked like. The idea that was a reoccurrence was that the groups conducting the rough drafts of procedures did not understand what the initial set up of the experiment looked like and

had to improvise with their own understanding of the text. Students observing their rough drafts being performed had to analyze their own perspective, then express it to the group conducting the experiment about what their vision actually looked like. From this reflection and analysis students began to emerge in critically thinking about what others were taking from their written work. Students in this process engaged in all aspects dictated in the goal, analysis of text, analysis of discussions, and peer sharing during a scientific process. However, the measurement of critical thinking was difficult to show through the evidence, especially with students often yielding to each other and not showing changes which reflected their thoughts throughout the process.

This project showed that Deaf students, with the proper supports can conduct experiments that are student driven. Some of the students were able to work together to achieve the goal of learning. However, only two of the four goals presented in this project were able to be supported through the evidence in implementation. The project succeeded in forming discussion groups as a foundation for student driven learning, but was not able to sufficiently show how student thinking was strengthened in the areas of analysis and critical thinking. There is trace evidence that does, however, show promise that with repeated exposure to this curriculum, students will be able to have more open discussions about their thinking and incorporate it in their writing process.

X. Conclusion

This project, although challenging was able to provide not only my students but also myself with a wealth of knowledge. The curriculum, although did not meet all goals, was successful in planting seeds within the minds of the students about working together and being creative in a tough academic area. For myself, this curriculum writing and implementation was an experience in developing materials for other educators to implement my vision of high quality writing within Deaf science classrooms.

In addition, I was able to develop a drive for the importance of bilingual education in the classroom. Bilingualism as part of this curriculum is a tool for student success. As such, I have learned that bilingualism is something that is an integral part of the classroom community rather than simply a label put onto a program or the languages in which that program is conducted. This curriculum is the embodiment of that ideal; students being able to experience their classroom as a fluid movement between languages of instruction with the ability to think and discuss academics in a variety of ways. As a new bilingual teacher I was able to put forth a work that supports students in their learning not simply in acquiring language, but in being able to use language as a tool for supporting each other as learners.

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XII. Appendices

Appendix A

Unit A: Introduction to Scientific Process

Lesson One: Hypothesis and Initial Research

Content Standard:

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations.

f. Distinguish between hypothesis and theory as scientific terms.

Language Objective:

Given graphic organizer and vocabulary, students will explore and explain thinking and research written/signed using graphic organizer as measured by teacher observations of oral/signed language in small group discussion and written work samples

Academic language functions: Explain a graphic organizer, and research on topic

Specific language structures and/or vocabulary: Action verbs, comparison words, science vocabulary pertaining to each topic.

Goal:

Students will create a hypothesis based in initial findings of research regarding theories, ideas, and understandings in science that are testable.

Objective:

Given tools to find credible sources, sentence frames, brainstorming bubble students will observe, explore, and report a hypothesis pertaining to physics concepts.

Materials:

1) Internet

2) Individual Hypothesis Brainstorming Page

3) Group Hypothesis Brainstorming Page

4)List of Physics topics to cover

5) Sentence Strips

6)Sample Hypothesis(Discussed in "Before the Lesson"

7) Whiteboard/Blackboard/Smart Board

Before the Lesson:

1) Students should be grouped into groups that the teacher considers to be balanced in literacy and language capacities as well as in gender if possible. in order for this curriculum to be fully explored from different viewpoints and opinion. These groups will be the groups that are used and referred to throughout the curriculum as a base for students to touch and continue to be in contact throughout their individual and group projects.

2) Before the lesson the teacher must prepare three to four hypotheses of varying vocabulary and support. Three examples are provided below and should be written on sentence strips or written/projected on the board:

Example One: My hypothesis is that all the experimental tubes of live yeast will die except for the positive control (the sample of live yeast cell with nothing added to it).

Example Two: It was my prediction that the liquids would have very different properties by their evaporation rate and molecular masses, although they have the same behavior as gases in the laboratory state. My prediction in the simplest terms is that the Acetone against the rubbing alcohol would have the greatest difference, followed by the Acetone and the ethanol. It is my prediction that the ethanol and rubbing alcohol would have the most similar properties.

Example Three: By simulating and making the rockets that I have designed to gather data in regard to flight time and height I predict that the control rocket, Xerampelinae, without payload in eggs, powered my an E-9-6 Estes Engine will fly to around 600 feet.

3) Copies of the Brainstorming Bubble are to be made, one for each student and one for each group, the students will be making individual predictions and group predictions for their experimental designs.

4) A blank whiteboard/blackboard/Smart Board should be set up to take note of the initial ideas of students with the word, "Hypothesis" on the top.

Lesson:

5 mins: The Lesson will start with the opening question, What is a Hypothesis? With students answering somewhere within the range of words pertaining to relating to "Scientific Processes". If students are struggling with adding related words they think connect, some follow up questions should be, "What do you think scientists start with when they want to do an experiment?" or "What are types of questions we ask when thinking about new concepts in class?" These questions during the warm up should be asked to invoke students to begin thinking about the scientific process.

20-40 mins:

To begin this section put up possible topics with experimental outcomes and have students write their group up for a project. The students should divide up research from this point and begin to discuss how to formulate a Hypothesis. The examples of hypothesis should be presented after students have picked a topic as prepared from above as examples to be read by the teacher. Students will then decide which example to follow on their own.

From this initial discussion ask students to form the groups you have created prior to the lesson. In these groups the expectations are to do three tasks on this day: Pick a Topic, Brainstorm individual and group hypotheses, and to begin researching.

Wrap Up:

5-10 mins After writing a hypothesis individually and as a group students should share their hypothesis by presentation, or by writing on the board. As a whole class discuss some challenges to writing a hypothesis, topics to suggest if discussion lags include clarity for others to understand each other's writing, group communication, finding resources, prior work on topics.

Modifications:

For a challenge, have students write the hypotheses, then write at least one supporting sentence for why they think they hypothesis is a feasible question. In addition, from this, students can correct each other's hypotheses for additional peer to peer support and English practice.

For students who require more support, have more than one group per topic and have a class wrap up comparing/contrasting different hypotheses, and construct one for both, or the whole class, focus on.

Assessment:

Students should turn in Brainstorming Chart at the end of the lesson, both individual and group. These are to be used in the next lesson, but will be assessed as part of the Unit grade using a rubric.

Next Lesson:

Discussion of ideas and collaboration with similar projects/ideas: Using the hypotheses we have to collaborate with other scientists in the class and reevaluating our ideas.

Lesson Two: Discussion and Collaboration

Content Standard:

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations.

d. Formulate explanations by using logic and evidence.

Language Objective:

Given sentence frames, script, and vocabulary, students will discuss and explain their thinking written/signed using words such as Hypothesis, not clear, clear, and explain as measured by teacher observations of signed language in partner discussions and small group final discussion.

Academic language functions: compare, explain, describe, and summarize.

Specific language structures and/or vocabulary: past tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia.

Goal:

Students will discuss previously formed hypotheses, provide and receive feedback to reconstruct and develop their hypothesis.

Objective:

Given scripts for collaboration students will analyze and reflect on previous work to provide a more cohesive argument on experimentation.

Materials:

1) Notepads/Notebooks(Students may use their own)

2) Stopwatch

3) Pencils

4) Group Brainstorming Page from previous Lesson

5) Individual Brainstorming page from previous Lesson

6) Script on SmartBoard/Blackboard/WhiteBoard/Large Poster

Before the Lesson:

1) Create the script of how you would like students to address each other as scientists. In this lesson, students should ask each other clarifying questions to solidify both their understanding of their own science concept to be explored and other unfamiliar concepts. The following is a sample script that can be modified to fit the needs of your students:

Person One: Please tell me your hypothesis.

Person Two: Reads Hypothesis.

Person One: That is interesting, how did you come up with that question?

Person Two: Responds

Person One: I am not clear about_____ and _____. Can you please explain to me what you mean by _____ and _____.

Person Two: Respond

Person One: What have other people done about this problem before?

Person Two: Respond.

SWITCH ROLES.

Lesson:

5 mins: Students should be asked to reconvene their groups from the previous lesson and their group brainstorm to be handed out to each group. Students will be given 2 minutes to discuss their thoughts about their potential experiment/topic and their hypothesis. After the two minutes are up, a role play with a student or other adult should be conducted using the script decided upon.

15-20 mins: Students will be asked to take notes regarding what other students were not clear on about the hypothesis and how they had to respond. Each student should go to a student in a different group and role play the script above, each pair will be given 5 minutes, 3 minutes to summarize and explain the hypothesis with a two minute warning to write down notes and reactions. After five minutes, switch roles and the subsequent person will have three minutes to summarize and explain and two minutes to write down reactions. A stopwatch should be used during this time to regulate the amount of time used for each pair.

Wrap Up:

10 minutes: Students are to go back to their groups and discuss findings about how other people reacted to their hypothesis, re-write if needed. For homework, the assignment is to flesh out the hypothesis and short supporting sentences on their own hypothesis based on the findings as a group.

Modifications:

For a challenge: Students during the discussion can add their own questions and answers to the script but explain during the wrap up why they added those other clarifying questions to their interviews. In addition students can expand and collaborate with their own team members to reflect on the hypothesis in a different way, as in “If we had written the Hypothesis this way, what would we say to support/defend our writing?”

For students who require more support: Students can help lead a whole class discussion on Hypotheses one at a time with students role playing in front of the class taking turns with teacher support to flesh out a good writing structure. In addition students could meet as indicated, but with a shorter script that uses only the questions regarding initial motive to write what they wrote, or support from the initial research.

Assessment:

Student Homework

Next Lesson: Filming student Final Hypothesis.

Lesson Three: Filming Final Hypothesis

Content Standard:

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations.

d. Formulate explanations by using logic and evidence.

Language Objective:

Given final English version of Hypothesis, students will translate and express using ASL their hypothesis using past tense verbs, future tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia as measured by teacher observations of signed language individually through the use of video.

Academic language functions: Explain a graphic organizer to show thinking and support examples of Hypothesis using ASL and written English.

Specific language structures and/or vocabulary: tense verbs, future tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia in both languages

Goal:

Students will be able to discuss previously formed hypotheses individually and as a group on film for final project.

Objective:

Given video and final draft of hypothesis students will explain their hypothesis on film.

Materials:

1) Final Hypothesis

2) Video camera or other video recording device

Before the Lesson:

1) Order students in random order from a roster of the students, this will help students see everyone's different hypothesis and not be tied to any particular group during the filming.

Lesson:

5 mins: Have students pair up with a new partner and explain their hypothesis using ASLonce, the students should explain their thinking behind their hypothesis.

10-15 mins: Students should be broken back up into their initial project groups, have each student translate their hypothesis into sign with either reading directly from the paper or re-writing key words on another sheet of paper. Each student should practice their hypothesis translation within the small group.

15-20 mins: Film each student explaining their hypothesis and watch as a whole class. During this time students should jot down feedback in their clarity or changes in vocabulary they would have made during signing.

Wrap Up:

10 minutes: Break students back into groups and have them discuss feedback in general about word usage or meaning in ASL.

Modifications:

For a challenge: Have students film their own Hypothesis and decide among the group which one is the most clear in English and which one is the most clear in ASL. Have the students compare the language functions and how the explanations differ between both languages. Use examples such as word count or forms of expression in both languages as guidelines for explaining differences between both languages.

For students who require more support: After filming each student, play their signing back to them, ask clarifying questions as a whole class. Supplement the transition between ASL and English with side by side comparisons, project the English writing next to the signing video and point to each English phrase as its being signed. This method of a kind of captioning can support student understanding of print as it relates to the signing.

Assessment: Video, Rubric for whole Unit.

Next Lesson:

Taking the homework from lesson one and expanding ideas into an introduction to the work/experiments to be done.

Lesson Four: Brainstorming Experiments

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked

probes, spreadsheets, and graphing calculators) to perform tests, collect data,

analyze relationships, and display data

b. Identify and communicate sources of unavoidable experimental error.

g. Recognize the usefulness and limitations of models and theories as scientific

representations of reality.

Language Objective:

Given experiment planning worksheet and previous filmed and written work, students will discuss and explain step by step process of experimentation written/signed using words such as First, second, third, establish, set up, assumption, materials as measured by teacher observations of signed language in small group/whole group discussions and written work samples

Academic language functions: analyze, explain, discuss graphic organizer, describe, summarize.

Specific language structures and/or vocabulary: First, second, third, establish, set up, assumption, materials

Goal:

Students will be able to create or model experiments based on their initial hypothesis and research to prove or work through theories in physics.

Objective:

Given experiment planning worksheet, previous hypothesis notes, and initial research on topic students will analyze and create a plausible experiment to prove or model ideal theories in physics.

Materials:

1) Experiment Planning Worksheet

2)Student work examples

3) Notebooks

Before the Lesson:

Make enough copies for students to each have a Planning Worksheet, from here on out the students work as the initial teams they worked in with their group hypothesis. Also prepare a mock presentation to walk students through the process of building an experiment with the worksheet frame by frame.

Lesson:

5 Mins: Have students arrange themselves into their groups for experimentation and have them discuss initial thoughts on building an experiment.

10 Mins: Walk students through worksheet with groups contributing ideas for a whole group “experiment” Questions to ask include, “What are variables?” “Why is it important to include variables in an experiment?” “What is an independent variable?” “What is a dependant variable?” “What are examples of each?” “Why do we start with our initial hypothesis?” “What is important to make sure everyone is safe during our

experiments?" "How many times do you think we should conduct the experiment to have accurate results?"

15-20mins: Have students create and work through making an experiment plan, what the variables will be, and how they intend on making the experiment fit their group hypothesis.

Wrap Up:

Have one or two groups share their Planning Worksheet and how they envision potential steps to actually complete the experiment (two to three thoughts, not a whole procedure or list)

Modifications:

For a challenge: Students can finish their initial worksheets then discuss among groups about experiment protocol, what are things that "real" scientists have access to and can incorporate into their experiments? In addition, students can get a second worksheet to complete as a team that "would have all the funding in the world", how would the students change their ideas and modify their experiments to "go bigger" or have multiple outcomes?

For students who require more support: Have the initial walk through of a whole class experiment for each group, in this manner every student can participate but still have whole class support about finishing their worksheets. Another possible access point for this lesson could be to have students be in their own groups but to have an additional worksheet with the questions discussed in the lesson printed up to have a "fill in the blanks" with a bullet list answering questions and transferring to the Planning Worksheet.

Assessment:

The completed worksheet to be graded along with the supporting hypothesis documents.

Next Lesson:

Planning Procedure and envisioning the actual experiments.

Lesson Five: Planning Procedure

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data

g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.

Language Objective:

Given sentence frames and vocabulary, students will create and write a procedure from discussion written/signed using First, second, third, establish, set up, assumption, materials in their written responses and signed discussion as measured by teacher observations of signed language in small group/whole group discussions and written work samples

Academic language functions: compare, explain, describe a process.

Specific language structures and/or vocabulary: First, second, third, establish, set up, assumption, materials

Goal:

Students will create and explain a scientific procedure created as a group incorporating ideas used throughout the Unit.

Objective:

Given background knowledge and the Planning Worksheet students will plan, synthesize, and collaborate ideas into a cohesive procedure to be executed as part of learning physics concepts.

Materials:

1) Notebooks

2)Any Materials needed for possible experimentation by students, lists vary based on experiments to be conducted(This can be found under supplemental material)

3) The Material List

4) The Procedure Worksheet

Before the Lesson:

Be sure to arrange the items that students will have access to on an open table, if possible, label each item. Create a flipchart or power point with each item picture and name as well. Make copies for each team of the Material List and the Procedure Worksheet.

Lesson:

5mins: Have students get into groups and discuss their paper from the previous lesson, paying special attention to the "How can we prove your physics concept" section.

5-10 mins: Hand out a "Material List" copy to each group and go through each item on the list with the visual support flipchart. Have students follow along and suggest possible uses for each item.

10-15 mins: Have students work through the Procedure Worksheet and fill in each section, then re-write the procedure onto a new sheet of paper with each section labeled in order without the boxes but as an actual procedure. Allow students to use materials as

necessary to plan their procedure but not fully conduct experiment. Students should use ideas from their research and build upon that knowledge.

10-20 mins: In the last portion of this lesson ask students to switch Procedures with another group. After exchanging papers students should pretend that they are about to run the other group's experiment. Have students read through the procedure and go through the collection of materials and setting up the experiment but not conduct it. After each group has set up the experiment have the original groups check the other teams work. Feedback should be given to make procedures more clear.

Wrap Up:

Have students put away all materials and go back to original teams, teams should write an exit slip answering the questions, "_____part in our procedure set up was easily understood, _____part of our procedure was difficult to understand and we need to add_____to have people understand our experiment set up better."

Modifications:

For a challenge(This challenge requires the teacher to prep or have available materials for every team to conduct every other teams experiment at the same time): After every team has written up their procedure have students present their procedure and have the remaining students set up the presenting teams procedure at the same time, the presenting team should lead discussion after set up about feedback, difficulties and clarifying questions during and after the set up. Repeat for each team.

For students who need more support: Take one experiment at a time and work through as a group about conducting an experiment. Make each student write through one step in the procedure with actual materials. Students could also take existing procedures and modify them to classroom materials available, for example, instead of using metal balls, what else that we have in the classroom can we use to do this same experiment?

Assessment:

Students will be assessed on a rubric and modifications as a whole unit. Students are to turn in all notes from the Hypothesis lesson to this lesson and will be assessed on a rubric before next Unit.

Next Lesson: Filming their final procedure to be conducted as an experiment.

Lesson Six: Filming Final Procedure

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked

probes, spreadsheets, and graphing calculators) to perform tests, collect data,

analyze relationships, and display data

g. Recognize the usefulness and limitations of models and theories as scientific

representations of reality.

Language Objective:

Given final English version of procedure, students will translate and express in sign their hypothesis using past tense verbs, future tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia as measured by teacher observations of signed language individually through the use of video.

Academic language functions: Explain a graphic organizer to show each step in the procedure written.

Specific language structures and/or vocabulary: tense verbs, future tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia

Goal:

Students will be able to describe each step of their procedure individually and as a group on film for final project.

Objective:

Given video and final draft of procedure students will explain the process they will do on film.

Materials:

1) Final procedure

2) Video camera or other video recording device

Before the Lesson:

1) Order students in random order from a roster of the students, this will help students see everyone's procedure and not be tied to any particular group during the filming.

Lesson:

5 mins: Have students pair up with a new partner and explain their procedure in sign once, the students should explain their thinking behind their hypothesis.

10-15 mins: Students should be broken back up into their initial project groups, have each student translate their procedure into sign with either reading directly from the paper or re-writing key words on another sheet of paper. Each student should practice their procedure translation within the small group.

15-20 mins: Film each student explaining their procedure and watch as a whole class. During this time students should jot down feedback in their clarity or changes in vocabulary they would have made during signing.

Wrap Up:

10 minutes: Break students back into groups and have them discuss feedback in general about word usage or meaning in ASL.

Modifications:

For a challenge: Have students film their own procedure and decide among the group which one is the most clear in English and which one is the most clear in ASL. Have the students compare the language functions and how the explanations differ between both languages. Use examples such as word count or forms of expression in both languages as guidelines for explaining differences between both languages. Have students discuss how the language may be different if more or less steps are written for the procedure.

For students who require more support: After filming each student, play their signing back to them, ask clarifying questions as a whole class. Supplement the transition between ASL and English with side by side comparisons, project the English writing next to the signing video and point to each English phrase as its being signed. This method of a kind of captioning can support student understanding of print as it relates to the signing.

Assessment: Video, Rubric for whole Unit.

Next Lesson:

Students should bring in by the next lesson a clean copy of the modified procedure for each student on their team. They will be conducting the experiments they have planned out.

You have reached the end of Unit A.

Unit B: Experimentation and Analysis

Lesson One: Running an Experiment

Content Standard:

Will vary based on Experimentation in addition to the following standard please look under Experiments for full disclosure of experimentation:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations.

Language Objective:

Given experimental procedure and sentence frames students will explain and discuss processes and observations using sign and write observations with the vocabulary past tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia as measured by teacher observations of signed language in small group/whole group discussions and written work samples.

Academic language functions: compare, explain an observation.

Specific language structures and/or vocabulary: past tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia.

Goal: Students will be able to set up and run experiments based on previously written procedures and collect data based on observations of physics phenomena.

Objective: Given data sheet, sentence frames and/or prompting questions, materials to conduct experimentation students will observe, interpret and collect data from various physics experiments.

Materials:

1) Data Collection Sheet, modified for each group of experimentations.

2)Sentence frames, to be discussed in "Before the Lesson"

3) Materials vary based on experimentation.

Before the Lesson:

Make enough copies of the Data sheet for each person in the group.

Have three levels of possible paragraph frames for students to use as part of their ongoing discussion during the experimentation, the following are samples of sentence frames that use the vocabulary used throughout these lessons. All three levels should also include the blanks-"Our independent variable is_____. Our independent variable is_____"

1) How many trials should we have for this experiment? We should have at least_____ for a good experiment because_____. What are some errors during the experiment that we should write down? _____and _____could be errors we need to write down as errors. Should we measure our units in the metric or the standard unit system? We should measure our units in the _____system because_____.

2) We should have at least_____trails for this experiment for a good design(3, 5, 10, 15). Some equipment errors we may run into are_____and _____. We should make sure to always measure our units in_____(Metric, Standard).

3) We will run our whole experiment _____times.(3, 5, 10, 15). We had problems with _____, _____, and _____ materials during our experiment. We measured our experiment time in_____(seconds, minutes, hours). Also, we measured our distances during our experiment in_____(inches, feet, yards, centimeters, meters)

Lesson:

5 mins: Have students input and discuss rules in the classroom for safety as well as equipment safety regulations, expectations for safety from each group. Have students break into their groups and have groups who will be conducting experiments outside discuss procedures for entering and exiting the classroom.

10-40 mins: Students will be running their own experiments during this time following the experimental procedures provided, written, and hypothesized about. At the end of each trail, and at the conclusion of their experimentation time students should discuss whether they felt they "proved" their scientific concepts, what they learned.

Wrap Up:

5-10 mins: Have an exit slip to write up from each group: "Today as a group we learned_____, and today as a group we found challenging_____"

Modifications:

For a challenge: Have students after running their own experiment, try someone else's set up for one trail on a rotating basis, that way every group has a chance to experiment another idea and make their own conclusions about the experiment, have students at the end of this experience debate about conclusions, whether they were able or not able to prove a concept with each experience. Have students write a short script on what they think could happen if they were able to conduct these experiments many times over the course of the entire semester hat would change? What could be the same?

For students who require more support: Have students rotate just as in the challenge, but have specific questions or a short description of what "should" happen at each station to have students looking out for the experiment conclusion to work out in a specific way. Possibly show videos or set up a video for each experiment to have students follow or better visualize what each station should be exemplifying.

Assessment: Exit slips will be the assessment of this particular lesson in addition to data sheet completion. This lesson will be part of a holistic assessment as part of the final project of this unit.

Next Lesson: Analyzing results from these experiments and working through basic statistics.

Lesson Two: Analyzing Results

Content Standard:

California Standards:

Probability and Statistics

This discipline is an introduction to the study of probability, interpretation of data, and fundamental statistical problem solving. Mastery of this academic content will provide students with a solid foundation in probability and facility in processing statistical information.

6.0 Students know the definitions of the mean, median, and mode of a distribution of data and can compute each in particular situations.

7.0 Students compute the variance and the standard deviation of a distribution of data.

Common Core Standards:

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

- CCSS.Math.Content.HSS-IC.B.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
- CCSS.Math.Content.HSS-IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

- CCSS.Math.Content.HSS-IC.B.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
- CCSS.Math.Content.HSS-IC.B.6 Evaluate reports based on data.

Language Objective:

Given data sheets and vocabulary students will describe and explain error in experimentation using signed language with vocabulary such as error, changes, control, experimental, variable, processes, mistakes, equipment fail as measured by teacher observations of signed language in small group/whole group discussions.

Academic language functions: compare, describe, explain.

Specific language structures and/or vocabulary: Error, changes, control, experimental, variable, processes, mistakes, equipment fail, past tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia

Goal: Students will be able to express in mathematical terms conclusions based on experimentations conducted in the previous lesson.

Objective: Given data collected from previous experiments, data sheets, and mathematical formulas, students will analyze and discuss results and conclusions mathematically, orally(signed).

Materials:

1) Data Collection sheets from previous lesson.

2) Data error worksheet

4)Pencils

Before the Lesson:

1) Create a varied “ideal” of graphs created with data points from “ideal” tests.

2) Print out enough Data Error Worksheets for each of the students

Lesson:

5 mins: Introduce students to the idea that math and science are linked through experimentation. Mathematics is the foundation for proving or disproving many phenomena in the science world, even if observed, scientists try and prove their ideas with the time they observed something, what was the number of the phenomena observed, explanation through writing and through proving with numbers facts.

10-15 mins: Work through with students an example problem such as this one worked out below, this particular problem is taken from a student science experiment, the “Calculated” or “True” percentage is taken from a physics concept, students “True” will vary based on experiment, the important part of this section is to explain to students that their full data sheets will be used for their calculations and that they will repeat this procedure for each trail. After the example, have students work out the first trail themselves including how they will figure out their “calculated” result, the rest of the trails are to be divided amongst the group for homework.

Times and Recorded Height:

Time

	Trial One	Trial Two	Average
Red	58.03 sec	54.34 sec	56.185 sec
Blue	41.71 sec	53.68 sec	47.695 sec
Yellow	32.12 sec	31.72 sec	31.71 sec

Height

	Trial One	Trial Two	Average
Red	784ft = 235.2 meters	728 ft =218.4 meters	756 ft = 226.8 meters
Blue	647ft = 194.1 meters	647 ft = 194.1 meters	647 ft = 194.1 meters
Yellow	333 ft = 99.9 meters	448 ft = 134.4 meters	390 ft = 117.0 meters

E-9-6 Engine:

Thrust: 10.22 N

Total Impulse: 29.95 N/s

Burn Seconds: 2.93 s

Height of Rockets Using Equations

Red Rocket (Average)

1) $J=F\triangle t$

$F = J/\triangle t$

F = (29.95 N/s)/ (2.93 s)

F =10.222 N

2) F = (F-mg)-(D)

F = ((10.222 N)-((.2545g) (9.8 m/s))-(2.5N)

F = 5.228

3) F = ma

a= F /m

a= (5.228)/(.2545)

a= 20.542

4) $v = v + at$

$v = 0 + ((20.542)(2.93))$

$v = 60.189$

5) $v = v + 2a\triangle y$

$y = ((v - v)/(2a)) + y$

$y = (((60.189) - (0))/((2)(20.542))) + 0$

y =88.178

6) $v_f = v_i + 2g\triangle y$

$y = ((v_f - v_i)/(2g)) + y_i$

$y = ((60.189) - 0)/((2)(9.8))) + 0$

y = 184.832 m

7) y + y = 273.01 m

8) % Error Calculation

(273.01-226.8)

(226.8) = 20.4 % Error

Wrap Up:

5 mins: Have students discuss who will calculate which trail and have students turn in the first calculated trail at this time.

Modifications:

For a challenge: Have students who understand how to find their calculated vs. their actual observation quickly, have students list possible sources of error, how could

they make the experiment not have such a high rate of error? What are causes of error? Scientifically, what counts as error?

For students who require more support: Instead of discussing error on a per trail basis, have students average all the trails into one trail and calculate that error for their experiment instead. In this manner each group has one problem to work through. In addition, students can be given their "Calculated" instead of having them think through what they think it is to have them focus on calculating error and difference instead. The main concept of this lesson is to have students learn that there is a "perfect" result, and a "scientific" result and that the difference is only about how close you have gotten to that result with your own experiments.

Assessment: Student Trail One, must have the following elements: Calculated estimation, Observed estimation, equations or concepts needed to find calculated estimation, % error. Will be graded as part of whole final project.

Next Lesson: Building graphs from error and data points.

Lesson Three: Making Graphs from Data Points

Content Standard:

California:

Probability and Statistics

This discipline is an introduction to the study of probability, interpretation of data, and fundamental statistical problem solving. Mastery of this academic content will provide students with a solid foundation in probability and facility in processing statistical information.

8.0 Students organize and describe distributions of data by using a number of differ ent methods, including frequency tables, histograms, standard line and bar graphs, stem-and-leaf displays, scatterplots, and box-and-whisker plots.

Common Core Standards:

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

- CCSS.Math.Content.HSS-IC.B.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
- CCSS.Math.Content.HSS-IC.B.6 Evaluate reports based on data.

Language Objective:

Given prompting questions and vocabulary, students will compare and contrast different graphic representations of mathematical results using signed language with vocabulary that includes graph, bar graph, line graph, spread, data points as measured by teacher observations of signed language in partners such as small group/whole group discussions.

Academic language functions: compare, contrast, describe

Specific language structures and/or vocabulary: graph, bar graph, line graph, spread, data points

Goal: Students will be able to create graphs and other representative diagrams based on error, data points, and other collected data.

Objective: Given graph paper, calculations and other collected data students will analyze, create, and display data in a significant mathematical representation (i.e. graphs).

Materials:

1) Graph paper

2) Pencils

3) Data Error Worksheet and Data Collection Sheets from previous lessons

Before the Lesson:

1) Make examples of different kinds of graphs, histograms, error boxes.

2) Have enough graph paper for each student to try to make bar graphs, box and whisker plots and any other relevant graphs.

Lesson:

5 mins: Have a short introduction to all graphs represented and how they are used. Examples include:

Bar graphs for data across trails, population, growth over time

Box and whisker plots, to show error between expected and observed trails

Line graphs, to show growth over time, outliers, each trial

Scatter plot, to show trends, overall averages.

10-20 mins: Have students create each kind of graph with their data points, starting with the averages and % errors, and move to plotting all data points manually. These graphs are rough drafts, but are meant to have students practice making graphs themselves. After this process, have students discuss as a group how the data is best represented and how best it could prove, or disprove, visually their group hypothesis. Questions for discussion include:

"Which graph appears to make the most sense?"

"Which graph type shows that we proved(or did not prove) our hypothesis?"

"Which graph is the most clear?"

"Which graph is the easiest to explain to other people?"

Wrap Up:

5-10 mins:

Have students decide on one or two graphs that they feel best shows the data and decide if they should expand to graphing each trail(if appropriate). For homework, have students clean up, and make a final graph with appropriate units, coloring, keys, etc.

Modifications:

For a challenge: Have students discuss among groups which graphs would be more appropriate for each experiment and track input with some kind of voting system. Have the students of each group agree or disagree with how the data should be represented and why, have them explain their stance on how the data should be displayed with evidence from their data, observations of experiment and/or how they feel their hypothesis should be proven or disproven.

For students who require more support: Walk each group through their appropriate graph, ideally each group that is completing a separate experiment should have a different kind of graph, have students explain what they notice about each kind of graph and connect to the specific experiment they are tied to. Students can make their own graphs from the experimental data, or can discuss trends among each other about what each graph looks like and what they represent.

Assessment: Students will have copies of their rough draft within their papers, students will be graded upon final project that includes graph.

Next Lesson: Filming Experimental process and initial results.

Lesson Four: Filming Experimental Process and Initial Results

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

d. Formulate explanations by using logic and evidence.

j. Recognize the issues of statistical variability and the need for controlled tests.

Language Objective:

Given collection of data and graphic representations, students will explain and describe process and results in ASL using past tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia as measured by teacher observations of signed language individually through the use of video.

Academic language functions: Describe experimental process and explain results of experimental data.

Specific language structures and/or vocabulary: tense verbs, future tense verbs, academic science vocabulary: force, theory, law, gravity, motion, energy, inertia

Goal: Students will be able to describe their experiments and initial results from collected data and graphic representations in ASL.

Objective: Given example results paragraphs, sentence frames and previous data students will inform in ASL their results from experimentation.

Materials:

1)Procedure, Data and Graphs

2) Video camera or other video recording device, if possible, have one video camera for each group.

Before the Lesson:

1) Randomize the order of project groups, students will take turns and decide who will describe which part of the procedure, data and graphs.

Lesson:

5 mins: Ask students to break into project groups and summarized everything that has happened during experimentation.

10-15 mins: Write on the board and/or show the three parts of this new video, Procedure, Data and Graphs. Students should choose among themselves who will be filmed in each of these roles by taking turns in explaining each part. Students should choose students to be filmed who use the most expressive ASL and/or descriptions in ASL that fully convey the meaning of each of these parts. The students should give as much detail as possible following the graphic organizers and prompting questions that have been used to stimulate their thinking so far in the scientific process.

15-20 mins: Pass out video cameras to each group and have them record themselves explaining each portion.

Wrap Up:

10 minutes: Break students back into groups and have them discuss feedback in general about word usage or meaning in ASL and how they describe their procedures and results.

Modifications:

For a challenge: Have students film their own experiences with procedure and results and compare them amongst each other. Who was the most descriptive? What kind of signs was this person using? What was the frequency of fingerspelling or setting up of actions? Have the students compare the language functions and how the explanations could differ between ASL and English when writing up what happened during experimentation. Use examples such as word count or forms of expression in both languages as guidelines for explaining differences between both languages.

For students who require more support: After filming each student, play their signing back to them, ask clarifying questions as a whole class. Supplement the transition between ASL and English with side by side comparisons, project the English writing examples from their already written procedure next to the signing video and point to each English phrase as its being signed. As them how what happened in during the actual procedure is different from what they had written. How can we go back and change it? This method of a kind of captioning can support student understanding of print as it relates to the signing.

Assessment: Video, Rubric for whole Unit.

Next Lesson:

Writing a results report with data, graphs, and initial findings.

Lesson Five: Writing Up a Report of Initial Findings

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

d. Formulate explanations by using logic and evidence.

j. Recognize the issues of statistical variability and the need for controlled tests.

Language Objective:

Given paragraph frames, video from previous lesson and vocabulary, students will describe and synthesize experimental results in writing and signed written/signed using descriptive paragraphs as measured by teacher observations of signed language in partners such as small group/whole group discussions and/or written work samples

Academic language functions: compare, synthesize.

Specific language structures and/or vocabulary: past tense verbs, physics vocabulary

Goal: Students will be able to write about their experiments and initial results from collected data and graphic representations.

Objective: Given example results paragraphs, sentence frames and previous data students will inform in writing their results from experimentation.

Materials:

1) Student Notebooks/Paper

2) Presentation or Print outs of possible results paragraphs

3) Paragraph Frames

4) Film from previous lesson

Before the Lesson:

1) Create the paragraph frame large enough for all students to see it if they choose to use it.

2) Make copies of the following master checklist for students to include in their paragraph:

1) What their initial idea or hypothesis was

2) What the ideal situation or experiment(in a perfect world) would show

3) What was the control of the experiment?

4) What were the variables in the experiment?

5) What was the procedure(briefly) and how was it modified(if at all)?

5) What were the results, data, trends that were collected(no personal observations)?

3) Example of a Results paragraph with supporting data:

Example One:

The results I obtained were that that all of the experimental graduated cylinders numbers 2-4 turned yellow which meant that they died. This was tested by getting some of the original bromothymol blue and blowing into it with a straw to see what color it would turn and it became green almost at the instant it came into contact with carbon

dioxide from my mouth. Otherwise it would have turned yellow as the others did. The positive control turned green as did the negative control which was odd because the negative was suppose to turn yellow as well because it was suppose to not be producing carbon dioxide.

Example Two:

The Results of my project were that we could make predictions about rocket height based on Kinematics equations used by physicists to conclusively get a ballpark number of how high a rocket go suing thrust and mass. However through trial and error we had to modify these perfect situation equations by adding a little real world variable, Drag. The drag of the rockets I designed was given form the computer program RocSim. When I had launched the rockets my teacher gave me the Kinematics equation and I set to work, however in the ideal conditions of a frictionless system the rockets should have attained a height of about 100 to 200 meters more than they could in an air resistant and drag included environment. I then set to find and equation for drag. Using the resultant of the tan of the angle we found the horizontal drag of the rocket by using wind speed and the given equation; however I found that we had made an error when I went to repeat the calculations, the fatal error was that we had forgotten to square the velocity.

Paragraph Frame:

My project about_____ was conducted as a group. Our hypothesis for this experiment was_____. We based this hypothesis on_____, _____, and _____ from these sources_____. The ideal experiment would conclude with_____. Our experiment varied from this because_____ and _____. We know this because our control variable _____showed_____. In contrast our experimental variable(s)_____ and _____ showed_____. During our experiment that we designed to_____and _____ by_____, we found that we had issues with_____. Thus our initial conclusion is that_____ is proven/not proven because_____.

Lesson:

5 mins: Introduce students to the idea of one to two paragraphs telling a direct story of what happened during the experiment. No opinion or other ideas, but rather a simple straightforward fact based paragraph or two. Show examples of how to write what happened and what they need to include in their paragraphs.

5 mins: Have students read in groups and identify elements in the example paragraphs of the master check list. What are the examples missing?

10-15 mins: Have students break into groups that they filmed in. Students should focus on the last two parts of the video. After re-watching their video explanations of initial results 3 times(explained below) of the procedure and results have students write notes that correlate with the master checklist of what to include in the results paragraph. Guide students in translating from ASL to written English with the following:

1) The first time you watch the video jot down general notes that you understood about the results of your experiment

2) The second time write specific signs and details you want to include in your writing.

3) The final time make sure that you've understood the details of your video and how you explained your experiment.

15 mins: Each student should write their own results paragraph but include that this experiment was done as a group. Students can choose to use the given paragraph frames or not, but must include all points on the master checklist.

Wrap Up:

5-10 mins: Have students exchange whatever rough draft they have with a partner and quickly check if they have, or do not yet have all items from the checklist, they are to write what numbers are missing from the partners paper on the bottom of the page.

Modifications:

For a challenge: Have students expand on their results to include their understanding of each trail, or every experiment.

For students who require more support: The students can all work on a common result, or instead of every student writing their own, have students write one as a group.

Assessment: Students will be graded upon their results having direct evidence from their experiment and the use and inclusion of each portion of the master checklist.

Next Lesson: Students will continue to write up different portions of their project and take a look at their results to see if they can improve or change something to have their experiment reflect closer the physics concepts they are looking for.

You have reached the end of Unit B.

Unit C: Writing a Scientific Paper and Presenting

Lesson One: How to write an Introduction

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

b. Identify and communicate sources of unavoidable experimental error.

c. Identify possible reasons for inconsistent results, such as sources of error or

uncontrolled conditions.

d. Formulate explanations by using logic and evidence.

Language Objective:

Given sentence frames and vocabulary, students will synthesize research information written/signed using the past tense and present tense of English to explain historical and present theories/laws of physics as measured by teacher observations of signed language in partners such as small group/whole group discussions and written work samples.

Academic language functions: synthesize information.

Specific language structures and/or vocabulary: past tense verbs, present tense.

Goal: Students will be able to write an introduction section to a scientific paper with appropriate sources, data and information based on research.

Objective: Given sentence frames, and examples students will synthesize research and new knowledge from their experiments to write an introduction section to a scientific paper.

Materials:

1) Sentence Frames

2)Examples, printed out or on a presentation/the board

3) Paper

4)All pervious materials/research from the students

Before the Lesson:

1) Create sentence frames based on what will be included in the introduction

Example:

Paragraph One(Introductory Paragraph):

The physics concept that will be explored in this paper is_____. This concept was first introduced by _____when they _____ and wrote/experimented/observed_____. Later _____(physics concept) was proven through_____ and is now expressed in science with_____. Today,_____(physics concept) can be seen in_____ and used for_____.

Paragraph Two(Science Concept Paragraph):

_____(physics concept) is the idea that_____. This is a force/theory/law/idea/phenomena that explains_____ and

how_____works in/on earth/the universe. _____(physics concept) is seen when _____ and_____. Some of the mathematical numbers/equations used are_____ where the variables_____stand for_____. One example of this is _____. People interact with _____(physics concept) through_____ when they_____.

Paragraph Three(Historical Paragraph):

People who have worked on proving and using _____(physics concept) include_____. To prove_____(physics concept)_____(historical person) explored this concept by_____. The works of_____(other person) were also influential in making this concept widely accepted.

Paragraph Four(Possible Error Paragraph):

The experiment that has been prepared was conducted in the classroom/outside/as a closed system at_____(school/location/city). Some limitations of this experiment were that_____.

2) Print out or put up the example paragraphs:

Examples:

Science Concept Paragraph(Paragraph Two):

The ideal gas law can be derived for the first principles of chemistry and physics using the kinetic theory of gases, simplifying everything possible by making assumptions such as the "ideal gas idea". Such as that the molecules of the substance have no attraction to each other, posses no mass, nor have any significant value. In other words all the collisions between the molecules within the substance itself are perfectly elastic and there are no intermolecular attractive forces (as mentioned above). It can be modeled as many perfectly hard spheres which collide but which otherwise do not interact with each other. In this Ideal gas state all the internal energy is in the form of kinetic energy and any change in internal energy is accompanied by a change in

temperature. An ideal gas can be characterized by three variables: absolute pressure (P), volume (V), and absolute temperature (T).

Historical Paragraph(Paragraph Three):

Rocketry is a hobby which has taken up the interest of people since the 1957 launch of the Russian satellite sputnik. This launched much more than the first advancement of a vessel in space, it launched the space race between the US and Russia to get the first people into space. As a result Rocketry became an important focus of our culture. As the excitement of the space race died and the first man made it to the moon, rocketry has not been a focal point of our society.

Possible Error Paragraph(Paragraph Four):

In part the procedure and materials used could have had a significant effect on the experimentation, however I believe that the most determinant factor of the conclusion is the rubbing alcohol. This experiment was conducted in a high school science laboratory and many impurities in the supplies and water could have contributed to the results of this study.

Lesson:

5 mins: Introduce the students to how they would explain their experiment to another science classroom on your campus. What information would they need? How can they explain where they got their ideas? Direct students to remember the initial lessons at the beginning of curriculum that include their research on the subjects they are exploring. How can they use the information to present it to someone for the first time?

10-20 mins: Have students break into groups with example paragraphs. Have students discuss in which order to best present the three parts of their introduction: Historical, Possible Error, and Physics concept for clarity. These paragraphs can go in any order they choose. Students are to individually write each paragraph up but are expected to work in groups and collaborate on a united structure for their introduction. Students can use the sentence frames and example paragraphs for structure.

Wrap Up:

5-10 mins: Have students take turns reading different paragraphs(The first, the second, the third, the fourth). Each student should write an exit slip answering the following questions: “What was the hardest paragraph to write and why?” “What was the easiest paragraph to write and why?”

Modifications:

For a challenge: Students can collaborate on writing an additional “group” paper where they use collective words and phrases, “we researched, we decided, our hypothesis indicated”, during this time students can decide the unified message and to delegate tasks/paragraphs and editing amongst group members.

For students who require more support: Take this lesson one paragraph at a time. If the whole class is focusing on one experiment have student groups write one collective paragraph and break each sentence frame down via the experiment. Tap prior knowledge by using the procedure, data, and hypothesis as a starting point for each paragraph, procedure for errors, data for physics concept, hypothesis for historical perspectives.

Assessment:

For this particular lesson, the exit slip will be a form of assessment, the rough drafts will be graded along with final paper.

Next Lesson:

Writing a conclusion while looking at the experiment as a whole and looking at results.

Lesson Two: Writing a Conclusion

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

b. Identify and communicate sources of unavoidable experimental error.

c. Identify possible reasons for inconsistent results, such as sources of error or

uncontrolled conditions.

d. Formulate explanations by using logic and evidence.

Language Objective:

Given paragraph frames and vocabulary, students will write and describe conclusions based in further understanding of scientific processes written/signed using past tense verbs and physics vocabulary as measured by teacher observations of signed language in partners such as small group and written work samples.

Academic language functions: Summarize

Specific language structures and/or vocabulary: past tense verbs, comparison words, physics vocabulary.

Goal: Students will be able to write a conclusion based in reflective writing and analysis of experimental process.

Objective: Given written results, introduction and experimental notes, students will inform in writing a synthesis of concluding an experiment.

Materials:

1) Sentence Frames

3) Paper

4)All pervious materials/research from the students

Before the Lesson:

1) Create sentence frames based on what will be included in the introduction

Example:

In conclusion_____(hypothesis) was proved to be partially correct/fully correct/inaccurate. This is because_____(evidence) and_____(more evidence). I believe that_____(reason) was why we could/could not prove the physics concept of_____. During our procedure we were/were not able to observe_____(concept) through _____(experiment/procedure). This experience was valuable in learning _____, _____ and _____ because _____. In the future if this experiment was repeated I would change _____, _____, and _____ about _____(the procedure, the materials used, the data collection). In this way I would be able to _____better.

Lesson:

5 mins: With a partner have students discuss the process of writing up to this point in the curriculum. Guiding questions include: “How did you incorporate science in your writing?” “What do you feel is the most important part of a scientific paper?” “If you were to give one part of your work to someone who doesn’t know anything about physics, which part would you give them?(Procedure, introduction, conclusion, results) and Why?”

5 mins: Have students discuss what they believe to be the conclusion of their experiment as groups. “What have you learned?” “What are three things that you know now that you didn’t know before?” “How was this experiment helpful in understanding_____?”

10-20 mins: Students will not be given an example paragraph in this lesson, only frames. Have the sentence frames as separate useful frames with one the “In conclusion,___...” frame to be used as a standard first sentence for each paper but the only one. Encourage students to deviate from the frames and add as much as possible, have students expand their thoughts in their writing by adding as much as they’d like to this paragraph. Do not limit what they write as a conclusion, any thoughts, feelings about process, experimentation, frustrations and other information may be included.

Wrap Up:

5 mins: Each student should share with another student a sentence or two from their concluding paragraph and explain why they included that sentence(or sentences).

Modifications:

For a challenge: For the two first five minute sessions, have students fold a paper in half from the top of the paper to the bottom. Students can, during the introduction portions of the introduction and guiding questions write down answers to each question for themselves in the top portion of the folded paper, and responses or other people’s ideas about the same questions in the bottom portion. Using this as a guide have students include a paragraph or two to explain other people’s opinions about the process and have them start the paragraphs with, “The following were comments and ideas from other people on my team….”

For students who require more support: Instead of writing an outright paragraph, have students make several lists with the following suggested topics. “I learned….” “I thought it was hard when….” “I was able to…..” “I observed…” “My favorite part of this activity was…”

Assessment:

Self Evaluation

Students will grade themselves on this particular portion of the activity. Along with teacher rubrics for the final paper.

Next Lesson:

Putting together all parts and peer editing to clean up the final paper.

Lesson Three: Editing and Organizing a Paper

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

d. Formulate explanations by using logic and evidence.

Language Objective:

Given previous written works and examples students will compare rough drafts to final format expectations and give feedback written/signed using guiding questions as measured by teacher observations of signed language in partners and written notes in margins of student papers.

Academic language functions: compare, explain feedback with textual evidence.

Specific language structures and/or vocabulary: comparison words, feedback, written, details, adding, erase, add to.

Goal: Students will be able to peer edit a rough draft of a scientific paper with appropriate comments in margins and other tools.

Objective: Given a peer's rough draft of all parts of a paper, students will compare and evaluate the work to given feedback in oral(signed) and written form.

Materials:

1) As many different colored markers as possible

2) The student's already finished rough drafts

3) Paper

4) The list of the following elements and headings of a paper(Note: The bolded portions of this list have not yet been created):

Introduction

Purpose of Experiment

Hypothesis

Materials

Procedure

Variables and Controls

Data

Graph(s)

Results

Conclusion

Bibliography

Before the Lesson:

1) Create and make copies of the following examples if needed:

Purpose:

The purpose of this experiment was to calculate and compare the molecular masses of several substances in order to compare the substances at the molecular level.

With this information I hope to demonstrate the different chemical makeup of each substance in comparison to others of the same properties.

Materials:

- 6 test tubes, 13- X 100-mm
- Aluminum foil
- Ice water bath
- Needle
- 2 large beakers
- Test tube holder

Variables and Controls

Variables:

- The three different liquids (Acetone, Ethanol, Rubbing Alcohol)
- The time that the tubes were left in the boiling water

Controls:

- Volume of the samples taken
- Test tube sizes
- Manner in which each of the tubes was weighted
- Balance
- Hot bath

Bibliography, which will be formed from their initial research in Unit A and their sources from the worksheets in the first lesson of the curriculum.

MLA Format or APA Format

Lesson:

5 mins: Students are to gather all materials, papers, notes and any other supporting writing, data, graphs, pictures.

5 mins: Have students place what they would consider relevant under each heading and write at the top of that paper, neatly, the heading intended for each part. Assure students that they will not have all parts at this step.

10 mins: Pass out four new sheets of paper and have students add the following headings:

Purpose of Experiment, Materials, Variables and Controls, Bibliography. Information for each of these headings can be found in the other portions of the paper. For "Purpose of Experiment" students can use group and individual worksheets used in the first lessons about exploration of topic and hypothesis building to find reasoning for moving forward in experiment. Materials should be listed under procedure, they are to be re copied as their own section. Variables and Controls were also discussed during the building of the procedure and should be a list as well. Bibliography can be built with the first and middle research papers. Guide students through finding and jotting down where they can later find this information, they are not to write all these sections out at this time. At this time tell students the order(from above) that their paper should be organized in and have them shuffle papers to reflect this order and staple it.

10-15 mins: Pass out a marker to each student, hopefully each student has a different color, or at least colors don't repeat much within the group. Have students pass their now packet in the order above to at least 3 other people, they are to read through and comment in margins, circle unclear portions of writing, ask questions in margins or on the back or bottom of paper what they think will help make the paper more clear. Example Questions to ask each other and to think about is "What can make this part more clear?" "Is there anything missing from this paper?" "Was this person able to fully explain themselves here?" Spelling and other grammatical mistakes can be corrected if needed. Emphasize to the students that they are not to mark up the whole paper, nor have a large amount of their marker color on any one paper. Three to four helpful hints or comments is enough, then move on to another paper.

Wrap Up:

5-10 mins: To wrap up have two to three students share a comment that they felt came up a lot or struck them that was written as feedback on their paper and how they might address it.

Modifications:

For a challenge: Students can sit with a maximum of three partners. With the first partner have an exchange solely on spelling and grammar, focusing on written English mistakes and how to fix them. With the second partner have them discuss only about the explanations of physics concepts, what is confusing from the writing, how can you improve and elaborate on the concept? With the third partner, have the pair focus only on message, is the language academic or personal? What words or phrases can be changed to sound more like an academic paper than a letter to a friend or a text message?

For students who require more support: Students can do editing and feedback on a rotating basis with each other and the teacher. Have "stations" set up for group rotation and have students rotate in their groups. Students can start anywhere and must complete organizing their paper, finding the missing parts, peer editing, and teacher editing for more support. Have students move stations every five minutes.

Assessment:

This entire packet will be turned in as an addition to the final paper. By the next lesson students should be assigned to re-write, clean up, make new copies of, type up and bring in a final copy of their full written report.

Next Lesson: Students will grade each other on a rubric that will be evaluated along with the teacher rubric.

Lesson Four: Written for Clarity, Peer Reviews

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content

in the other four strands, students should develop their own questions and perform

investigations. Students will:

b. Identify and communicate sources of unavoidable experimental error.

d. Formulate explanations by using logic and evidence.

Language Objective:

Given peer feedback and rubrics, students will evaluate in written form peer scientific papers using comparison words as measured by written work samples.

Academic language functions: compare, evaluate

Specific language structures and/or vocabulary: Present tense, reading comprehension.

Goal: Students will be able to, as a group, evaluate each other's work and clarity in writing a scientific paper.

Objective: Given a rubric, students will evaluate and classify two papers in written form.

Materials:

1) Student Final Rubrics.

2) Student Self reflection Rubrics

2) Pens

Before the Lesson:

1) Make two copies of the Student Final Rubric for each student.

2) Make one copy of the Student Self Reflection Rubric for each student.

3) Randomize and pair up each student with two others in the class and make a list of this to post on the board.

Example:

Student A will evaluate the papers by Student G and H

Student B will evaluate the papers by Student A and L

Student C will evaluate the papers by Student Y and U

Lesson:

5 mins: Pass out Rubrics and have students discuss in pairs features of the rubric.

10 mins: Go through the rubric, explain that rubrics are used to evaluate features of a collective work. Rubrics are used to show what students have demonstrated through this paper and how they can improve their writing or work in the future. This final paper will be peer reviewed and teacher reviewed and will be graded based on an average score calculated through the three scores.

2 mins: Each student should write down the names of the people they will be evaluating.

10-20 mins: Put all papers at the front desk or other open tabletop area where the names can be clearly seen on each paper. Each student should pick up a paper that they have been assigned and return to their own seat to quietly read through and evaluate the report, when they are finished they return just the report to the same table to have the next

person to evaluate it. When they are finished evaluating both of their assigned papers have students grade their own with the Self Reflection Rubric, this rubric includes a reflection portion where students grade themselves on the processes.

Wrap Up:

5 mins: Have students list three things they liked about this lesson and three things they disliked about this lesson and the grading process on the back of their Self Reflection Rubric.

Modifications:

For a challenge: Students can write a paragraph commentary for each of the papers they grade on the back of the Student Final Rubrics as a form of feedback for each paper.

For students who require more support: Students can focus on the Self Reflection Rubric and instead of grading each other, discuss how they decided to grade themselves amongst each other.

Assessment:

Peer, personal and teacher Rubrics. Students are to turn their final papers, rough draft packet and rubrics to the teacher.

Next Lesson:

Discussing your paper, and how to make a short two minute presentation to someone else.

Lesson Five: Presenting your paper.

(Note: This lesson ideally should be taught about a week after the previous lesson)

Content Standard:

1. Scientific progress is made by asking meaningful questions and conducting careful

investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data

b. Identify and communicate sources of unavoidable experimental error.

c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

d. Formulate explanations by using logic and evidence.

e. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.

f. Distinguish between hypothesis and theory as scientific terms.

g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.

Language Objective:

Given final papers and script students will explain and summarize their scientific papers using American Sign Language as measured teacher observations of oral/signed language in partners.

Academic language functions: compare, explain, summarize, synthesize, describe.

Specific language structures and/or vocabulary: past tense verbs, comparison cue words, nouns, experimental processes, hypothesis, procedure, variables, physics vocabulary.

Goal: Students will be able to present the main points of their experimental process and physics concept in a short five minute presentation.

Objective: Given final paper as a guide, students will order and narrate their work to a peer using ASL as their final presentation.

Materials:

1) Stopwatch

2) Final Papers

3) Paper for Notes

Before the Lesson:

Ideally, have students present their papers to another classroom in their peer age group, students should be able to present their paper/findings to people who have never heard of these concepts before in five minutes as a brief presentation. The purpose of this lesson is to have students able to present the important parts of their learning to someone with no background in it and briefly explain how they came to learn it themselves. If not possible, pair students up with two different people than the ones whom evaluated their papers, this is to have students present their paper/topic to other students who haven't already read their paper.

Lesson:

5 mins: Pass back final papers to students, explain that they will have five minutes to read through their final papers and decide how to best present their paper in five minutes or less.

5 mins: On the back of their final page have students write down “speakers notes” or the important points that they feel they need to touch upon during this short presentation.

15 mins: Have students pair up with their first person and start stopwatch for five minutes. Repeat for students to present their topic to at least one other student. Students should pretend that they have never meet the person they are meeting with before and introduce themselves by name(and name sign), their short presentation and end with a thank you and a handshake every time.

Wrap Up:

5-10 mins: Have students write a short response to the following questions: What did I remember most about my project when I re-read it before the presentations? What were my three most important points from my paper? What can I do to improve my short presentation skills? What was something that I had to explain better for my partner to understand?

Modifications:

For a challenge: Students can present papers to much younger students(middle school or late elementary school) as opposed to peers to add a challenge in accommodating language and explaining advanced concepts in the simplest forms possible.

For students who require more support: Have students make a group presentation from their original experiment groups, give students 10 minutes instead of five and present to another class what they did to learn their concept.

Assessment:

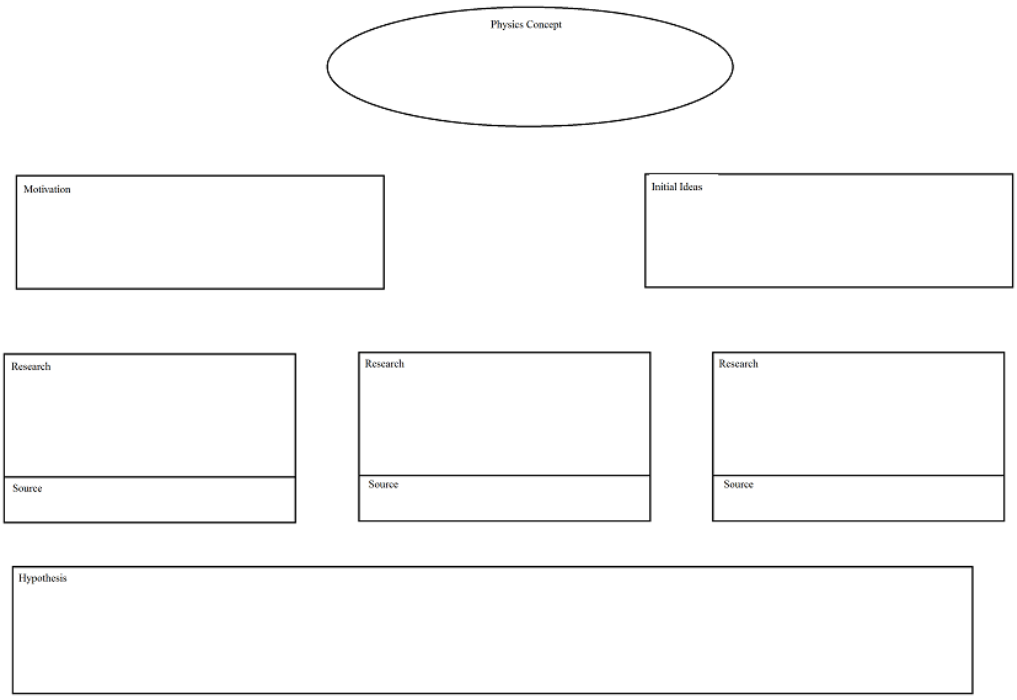
Final assessment will be the teacher rubric which includes a part on the oral(signed) presentation.

You have reached the end of Unit C.

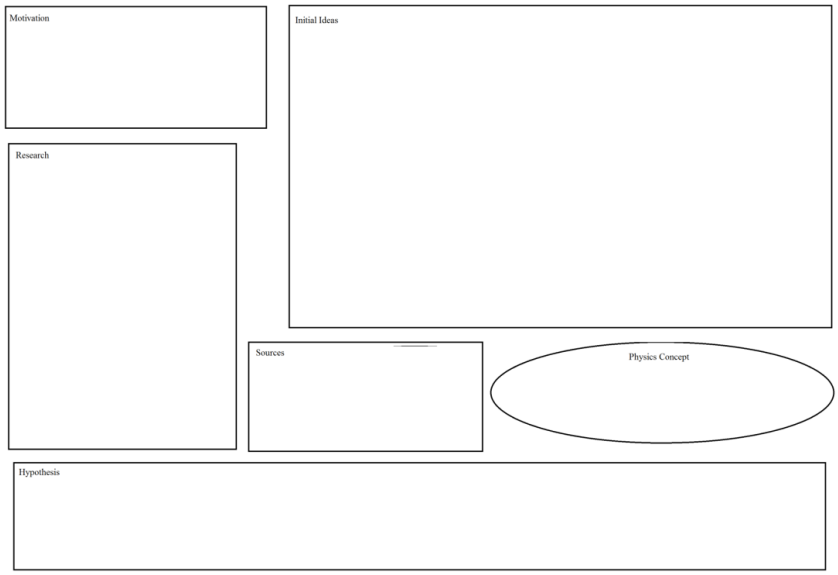
Appendix B

Worksheets

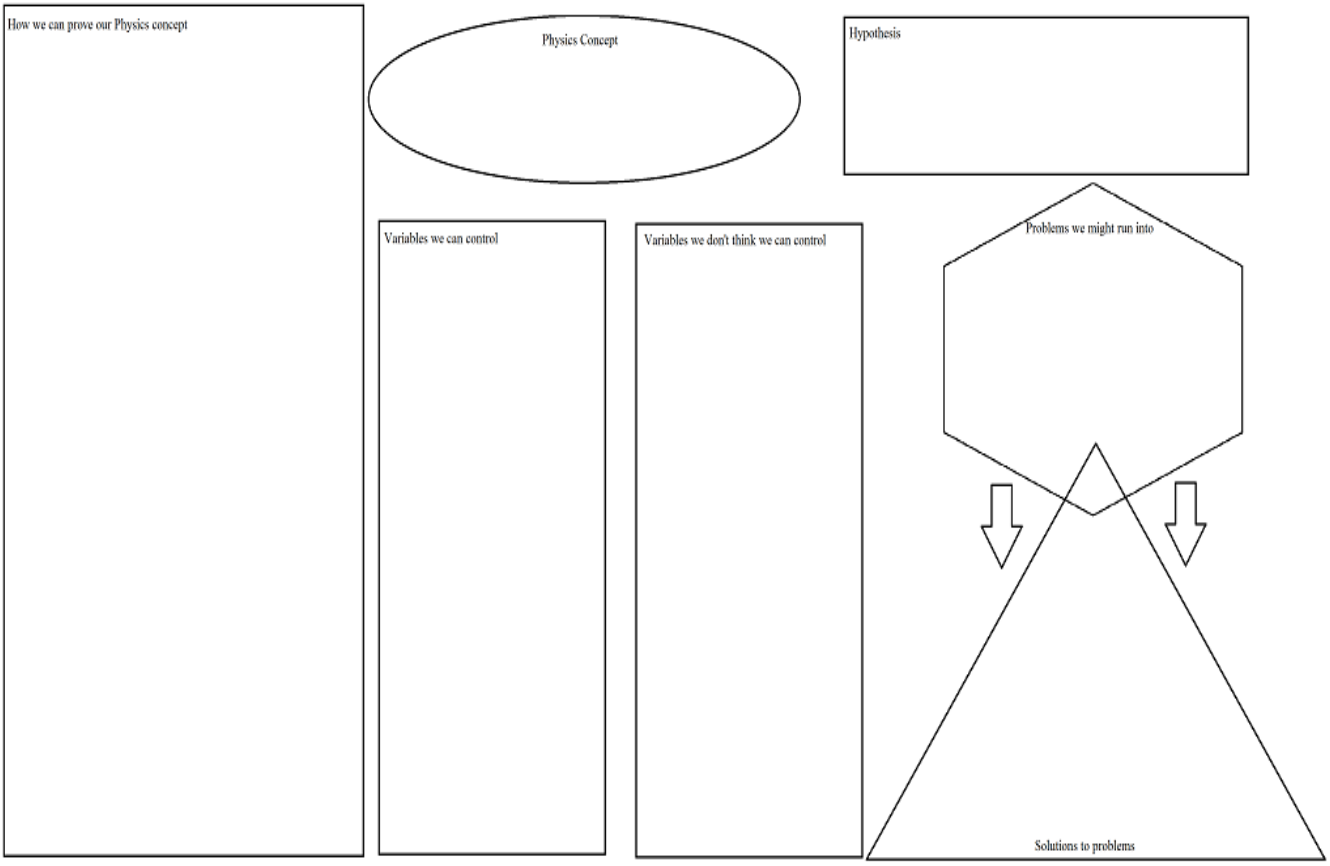
Supporting Document 1A: Individual Hypothesis Brainstorming Page (Unit A Lesson One)



Supporting Document 2A: Group Hypothesis Brainstorming Page (Unit A Lesson One)

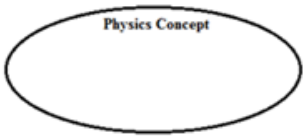


Supporting Document 3A: Experiment Planning Worksheet(Unit A Lesson 4)



Supporting Document 4A: Material List(Sample, Modify to your own) (Unit A Lesson 4)

Names:_____
Date:_____
Period:_____



	Material Name	How Many?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
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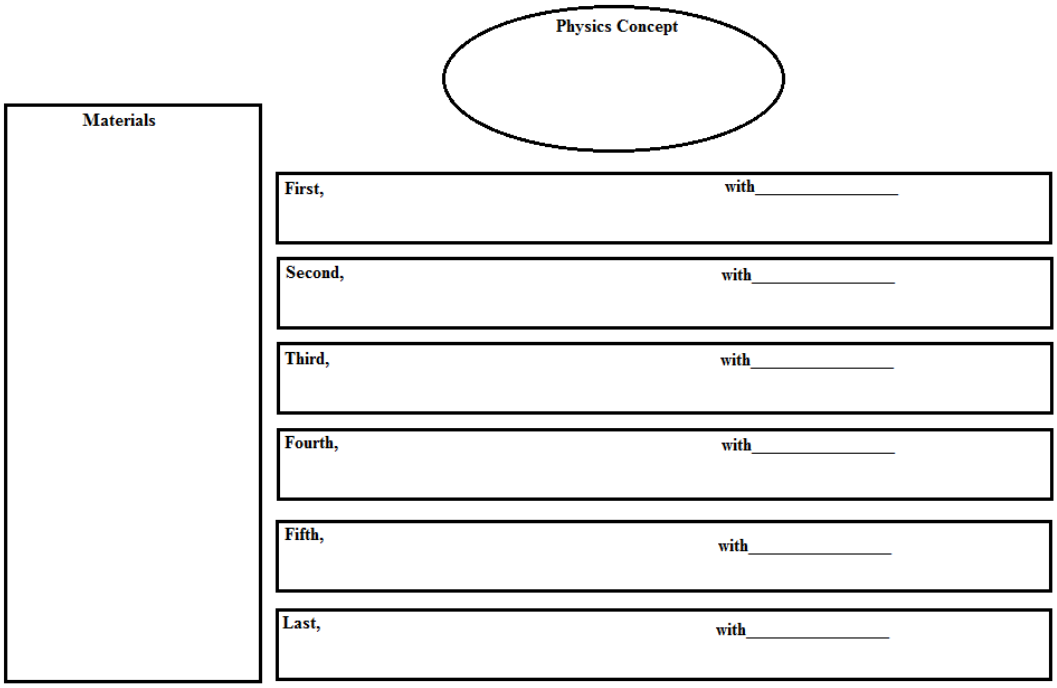
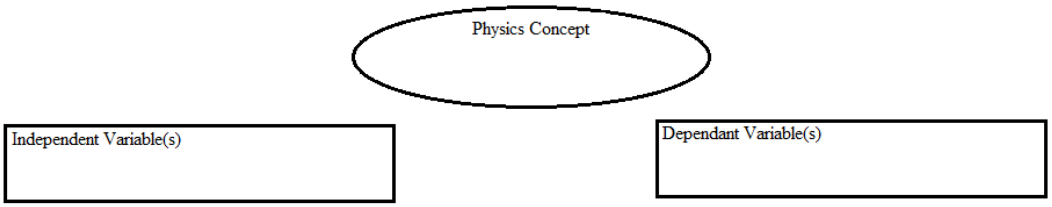
28		
29		
30		

Supporting Document 5A: Procedure Planning Worksheet(Unit A Lesson Five)



Supporting Document 1B: Data Collection Sheet, these are possible examples, can be modified to fit your own experiments. (Unit B Lesson One)

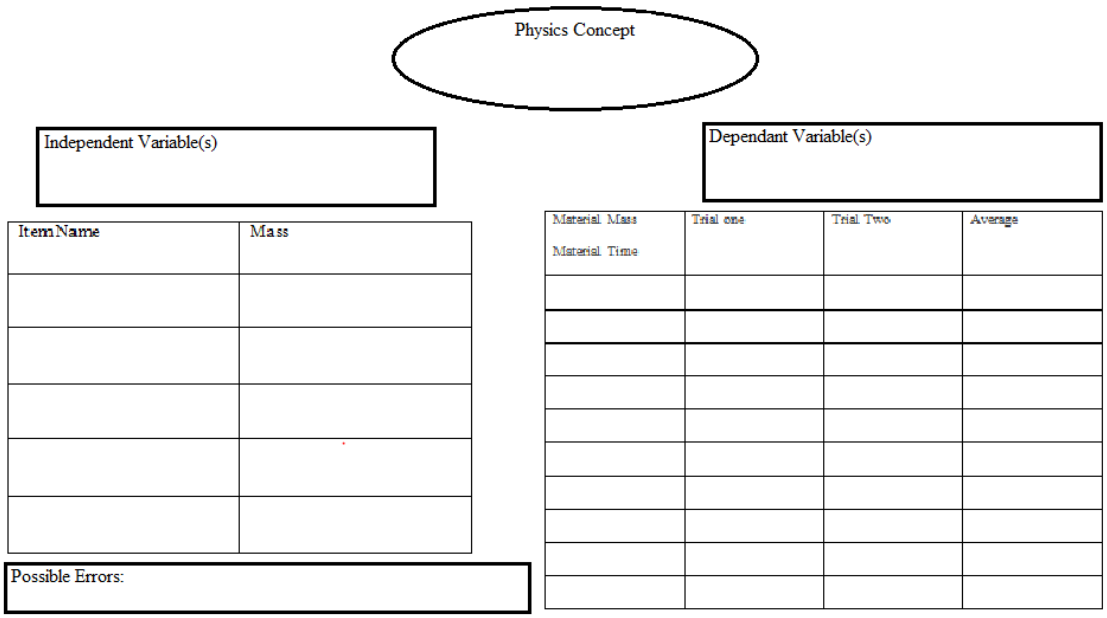
Example One:



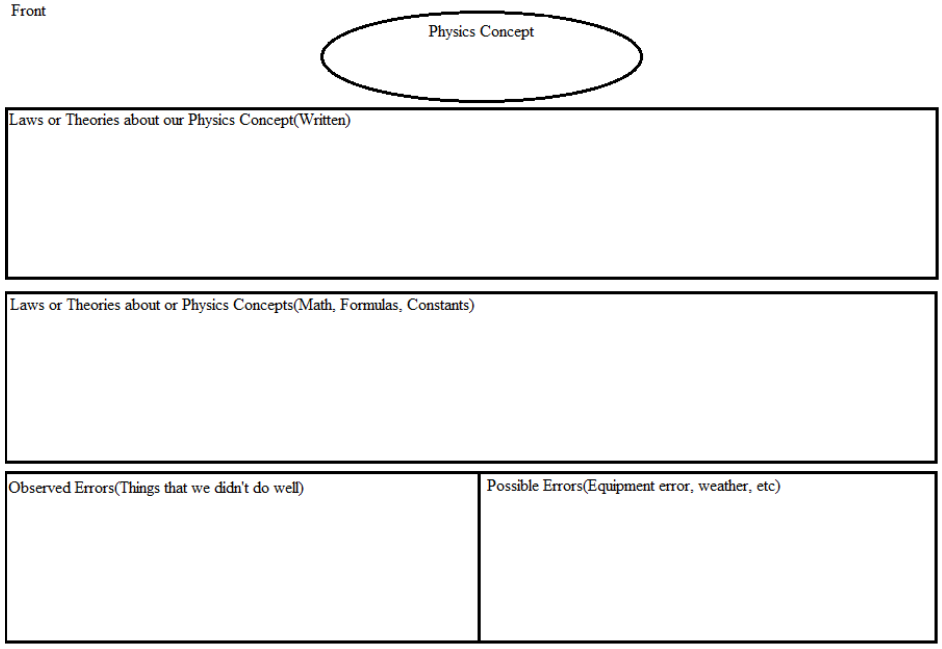
Item Name	Mass

Trail	Time(s)						
	5	10	15	20	25	30	35
1							
2							
3							
4							
5							
Average							

Example Two:



Supporting Document 2B: Data Error Worksheet(Unit B Lesson Two)



Back

Trail Number	Observed(Average from previous sheet) [1]	Calculated [2]	Percent Error
#1			
#2			
#3			
#4			
#5			
#6			

$$\% \text{ Error} = \left(\left| \frac{\text{Calculated}_{[2]} - \text{Observed}_{[1]}}{\text{Calculated}_{[1]}} \right| \right) \text{X } 100$$

Trail 1

$$\% \text{ Error} = \left(\left| \frac{\quad}{\quad} \right| \right) \text{X } 100$$

Trail 2

$$\% \text{ Error} = \left(\left| \frac{\quad}{\quad} \right| \right) \text{X } 100$$

Trail 3

$$\% \text{ Error} = \left(\left| \frac{\quad}{\quad} \right| \right) \text{X } 100$$

Trail 4

$$\% \text{ Error} = \left(\left| \frac{\quad}{\quad} \right| \right) \text{X } 100$$

Possible Experiments with Possible Procedures

Newton's First Law

b. Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).

Penny in a cup:

http://www.metrofamilymagazine.com/July-2012/Simple-Science-Experiments-Newtons-First-Law-of-Motion/

Balls:

http://www.metrofamilymagazine.com/July-2012/Simple-Science-Experiments-Newtons-First-Law-of-Motion/

Newton's Second Law

c. Students know how to apply the law F=ma to solve one-dimensional motion problems that involve constant forces (Newton's second law).

Ball Bearings:

http://swift.sonoma.edu/education/newton/newton_2/html/Newton2.html

Cars:

Hot Wheels Experiment: http://www.ehow.com/list_6952612_second-law-motion-experiments.html

- Construct a simple ramp that's 18 inches high and about 24 inches long using a piece of thin plywood and bricks. Place a toy car at the top of the ramp. Release it and measure

how far it rolls. Tape two metal washers to the car, release it from the ramp and measure how far it rolls. Repeat the experiment with five washers taped to the top of the car. This experiment shows that as mass increases with gravity's constant acceleration, the force pushing the car along the floor increases, making heavier cars travel farther.

Newton's Third Law

d. Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).

http://www.ehow.com/way_5417236_newtons-law-motion-science-project.html

1. Rolling Balls Experiment
   - You can perform another simple experiment using a collection of balls. You should have at least two balls of the same size and mass, as well as several other balls of varying sizes and masses. Roll the balls along a flat surface toward each other. When the balls collide, watch the results of the collision. When the two balls are the same mass and travel at the same speed, they should simply reverse their motion upon impact. Vary the speed of the balls' travel to produce different forces from identical balls. Test the impact of balls of differing masses as well. Following impact, larger mass balls will move less than smaller mass balls. They will, however, continue to follow Newton's law and will move in opposite directions with equal total force.

Rocket Wagon Experiment

- A final activity to demonstrate Newton's Third Law of Motion is a simulation of rocketry. You can create your own "rocket" using a wagon and a fire extinguisher. Have the rocket pilot sit in the wagon, holding the extinguisher. Point the extinguisher in the air behind the wagon and pull the trigger. The quick release of gas and extinguisher foam will cause the mass of the wagon to move in the opposite direction. Exercise caution when performing this experiment, and make sure there are no obstacles for the wagon or the extinguisher to hit.

Gravity

e. Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.

f. Students know applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).

E. Dropping objects and timing them:

Ruler, timer, objects.

F. Balls on a flat plane, hitting them with a pencil, changing direction, charting their direction with paint, time them with a timer.

Energy

h.* Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.

3. Energy cannot be created or destroyed, although in many processes energy is trans ferred to the environment as heat. As a basis for understanding this concept:

a. Students know heat flow and work are two forms of energy transfer between systems.

Having students boil the water, or ice cubes and watch as the water becomes bubbly, imagining and charting molecule movement in each stage. Weighing mass of water at each stage in conservation of energy/mass, etc.

Bottle of soda, shaking it, feeling the pressure, understanding a bottle is a closed system, that changes, over time the molecules will no longer be pressuring the bottle of soda, no matter is lost, energy from shake goes back into soda.

First Law of Thermodynamics

Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.

c. Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.

d. Students know that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.

Using a cooler vs. having things out in a room, observing temperature fluctuations from an ice cube(or several of them) and watching them melt and reach same temperature as the room or the outside, having students boil the water, or ice cubes and watch as the water becomes bubbly, imagining and charting molecule movement in each stage. Weighing mass of water at each stage in conservation of energy/mass, etc.

Second Law of Thermodynamics

e. Students know that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.

f.* Students know the statement “Entropy tends to increase” is a law of statistical probability that governs all closed systems (second law of thermodynamics).

Deck of cards experiment, within a closed system, or a deck of cards, the randomization of the cards increases, or rather will always become more chaotic, probability of it ever becoming smaller or the same as it was when it was first opened(the package) is so small it's impossible. .

Waves

a. Students know waves carry energy from one place to another.

b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).

Slinkies, and using them to create different waves. Pinning and object(such as a foam ball) and making watching it move up and down but not around, feeling the “energy” move from one side of the wave to the next, charting the same amount of energy across different distances.

Vocabulary

Control Variable: Variables or subjects during experimentation that are a baseline, those that act according to expected results, those variables or subjects that are not changed in any way for the experiment.

Experimental Variable: Variables or subjects that have one or more qualities or actions changed through the process of the experiment. They are compared to the control variables to provide data in changes from the baseline.

Constant: A mathematical quantity that has been standardized and accepted by the math community as a given in physical or mathematical processes and theories.

Law(Physics): A principle in physics to explain natural phenomena that uses mathematical equations to support it, can be observed or is continually observed, is not expected to change or be altered due to any added variable.

Theory(Physics): A theorized, mostly proven principle used to explain natural phenomena that uses mathematical equations to support it, cannot be observed or is difficult to observe but is widely accepted and used as canon.

Energy: An observed quantity that comes in different forms including but not limited to: Kinetic energy(energy of movement), potential energy(the energy an object potentially can exert), chemical energy(energy in bonds of molecules), thermal energy(the energy in heat and light).

Entropy: A thermodynamic quantity that accounts for the flow of energy released by a thermodynamic process which is lost from the system. A mathematical phenomena where energy is continuously transferring and cannot be reformed into its original formation.

Conservation: The concept that mass and energy are neither created nor destroyed by physical processes but transferred and changed over time.

Force: The action of some energy onto an object which causes it to move from rest or in a different direction.

Error: The difference between the baseline or control value and the changes or experimental value of processes.

Observation: The scientific process of looking at an experiment and recording it in a manner that other people can understand what you have experienced or observed.

Procedure: The scientific steps taken to achieve an experiment.

Hypothesis: An educated guess based in prior research that is extrapolated from a base of general understanding of a concept or natural phenomena which will be tested or changed to observe if the guess of outcomes is or is not provable.

Formula: A mathematical expression which is applied to different mathematical and scientific ideas that results in an answer to the question of value of different processes.

Inertia: The inherent energy in an object has that allows it to continue to be in motion(when no other forces act on it) or continue to be at rest(when no other forces act on it).

Final Paper Format

Introduction:

Unit A, Lesson 1 Unit C Lesson 1

Purpose of Experiment

Unit A, Lesson 1

Hypothesis

Unit A, Lessons 1, 2, 3

Materials

Unit A Lessons 3, 4 Unit B Lesson 1

Procedure

Unit A Lessons 3, 4

Variables and Controls

Unit A Lessons 2, Unit B Lesson 1, 2

Data

Unit B Lesson 2, 3

Graph(s)

Unit B Lesson 4, Unit C Lesson 2

Results

Unit B Lesson 3

Conclusion

Unit C Lesson 2, 3

Bibliography

Unit A Lesson 1, 2 Unit C Lesson 1

Final Paper Example.

Expectations of Report:

1) Write as much as possible! You have all the information, if you need more please look for more!

2) Please follow this format, also: 12 font, New Times Roman, Double Spaced

3) All pictures/graphs MUST have a caption saying what they are with a "Fig. #" at the beginning.

4) AT LEAST 3 sources of information.

5) You will be graded on a 4,3, 2, 1, rubric please try your best I can show you the rubric again this is your final grade for my class.

Last, VERY IMPORTANT

Work together with your group, you should have all the same information, but ***write your own report.***

There are things that will be exactly the same like the materials, the procedure, and the hypothesis. Everything else should look a little different! ***Write using your own words, but work together.***

"Physics Topic"

Your Name

Name of Everyone Else in your Group

Date Due: May 30, 2013

Period:_____

Table of Contents:

Introduction

Paragraph One(Introductory Paragraph):

The physics concept that will be explored in this paper is_____. This concept was first introduced by _____when they _____ and wrote/experimented/observed_____. Later _____(physics concept) was proven through_____ and is now expressed in science with_____. Today,_____(physics concept) can be seen in_____ and used for_____.

Paragraph Two(Science Concept Paragraph):

_____(physics concept) is the idea that_____. This is a force/theory/law/idea/phenomena that explains_____ and how_____works in/on earth/the universe. _____(physics concept) is seen when _____ and_____. Some of the mathematical numbers/equations used are_____ where the variables_____stand for_____. One example of this is _____. People interact with _____(physics concept) through_____ when they_____.

Paragraph Three(Historical Paragraph):

People who have worked on proving and using _____(physics concept) include_____. To prove_____(physics concept)_____(historical person) explored this concept by_____. The works of_____(other person) were also influential in making this concept widely accepted.

Paragraph Four(Possible Error Paragraph):

The experiment that has been prepared was conducted in the classroom/outside/as a closed system at_____(school/location/city). Some limitations of this experiment were that_____.

Hypothesis

Your Hypothesis goes here, it should be one to two sentences, including a couple of supporting facts.

Purpose of Experiment

Here you should write about how you picked your topic, how your group discussed how to pick the topic. What was the process of the whole experiment as a group. Please write as much detail as possible.

In a new paragraph please write your PERSONAL experiences throughout the whole process. What you liked, what you didn't like what you learned. Please write as much as possible.

Materials

- 6 test tubes, 13- X 100-mm
- Aluminum foil
- Ice water bath
- Needle
- 2 large beakers
- Test tube holder

Procedure

1) This is where you write your procedure looking like this.

2) Please write in full sentences your directions

3) Try as much as possible to fix and edit your sentences to make sense

4) Thank you.

Data

Times and Recorded Height:

Time

	Trial One	Trial Two	Average
Red	58.03 sec	54.34 sec	56.185 sec
Blue	41.71 sec	53.68 sec	47.695 sec
Yellow	32.12 sec	31.72 sec	31.71 sec

Height

	Trial One	Trial Two	Average
Red	784ft = 235.2 meters	728 ft =218.4 meters	756 ft = 226.8 meters
Blue	647ft = 194.1 meters	647 ft = 194.1 meters	647 ft = 194.1 meters
Yellow	333 ft = 99.9 meters	448 ft = 134.4 meters	390 ft = 117.0 meters

Graph(s)/Pictures

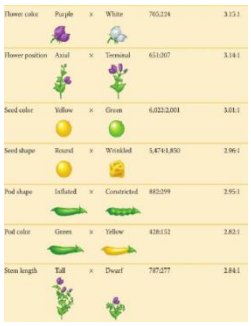
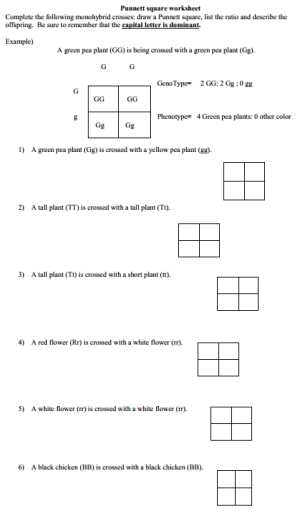


Fig. 1 Pictures explained in Lesson that would be shown one by one the dominant and recessive expression of genes.



Punnett square worksheet

Complete the following monohybrid crosses: draw a Punnett square, list the ratio and describe the offspring. Be sure to remember that the **capital letter is dominant.**

Example)

A green pea plant (GG) is being crossed with a green pea plant (Gg).

	G	G
G	GG	GG
g	Gg	Gg

GenoType= 2 GG: 2 Gg : 0 gg

Phenotype= 4 Green pea plants: 0 other color

1) A green pea plant (Gg) is crossed with a yellow pea plant (gg).

2) A tall plant (TT) is crossed with a tall plant (Tt).

3) A tall plant (Tt) is crossed with a short plant (tt).

4) A red flower (Rr) is crossed with a white flower (rr).

5) A white flower (rr) is crossed with a white flower (rr).

6) A black chicken (BB) is crossed with a black chicken (BB).

Fig. 2 Worksheet with Punnett Squares, introduction to process of solving

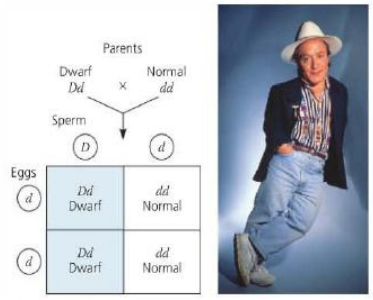
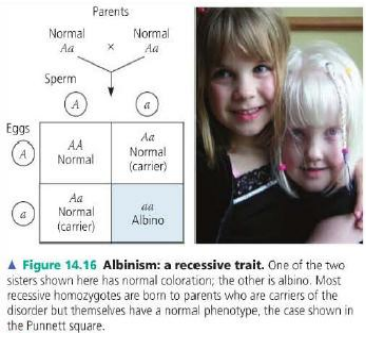


Fig. 3 Dominantly inherited Gene



▲ **Figure 14.16 Albinism: a recessive trait.** One of the two sisters shown here has normal coloration; the other is albino. Most recessive homozygotes are born to parents who are carriers of the disorder but themselves have a normal phenotype, the case shown in the Punnett square.

Fig. 4 Recessively Inherited Gene with Paragraph Explanation

Results

My project about_____ was conducted as a group. Our hypothesis for this experiment was_____. We based this hypothesis on_____, _____, and _____ from these sources_____. The ideal experiment would conclude with_____. Our experiment varied from this because_____ and _____. We know this because our control variable _____showed_____. In contrast our experimental variable(s)_____ and _____ showed_____. During our experiment that we designed to_____and _____ by_____, we found that we had issues with_____. Thus our initial conclusion is that_____ is proven/not proven because_____.

Conclusion

In conclusion_____(hypothesis) was proved to be partially correct/fully correct/inaccurate. This is because_____(evidence) and_____(more evidence). I believe that_____(reason) was why we could/could not prove the physics concept of_____. During our procedure we were/were not able to observe_____(concept) through _____(experiment/procedure). This experience was valuable in learning _____, _____ and _____ because _____. In the future if this experiment was repeated I would change _____, _____, and _____ about _____(the procedure, the materials used, the data collection). In this way I would be able to _____better.

Bibliography

1) Here, please list your sources from your research, write down the book name, title, author and page number where you got your information

2) If you used an internet site please put down the www._____.com, and the topic of information you found, or the title of the webpage or company.

3) You should have ***at least*** 3 sources. Please try to have more, add more to your introduction!

Appendix C

Rubrics

Unit A

Teacher Rubric

Hypothesis	4	3	2	1
Worksheet-Individual	Worksheet is completely filled out with clear language for each category. It describes much with great detail what each category is asking.	Worksheet is mostly filled out with understandable language for each category. It describes enough detail to understand what each category is asking.	Worksheet is partially filled out with some clarity in language to explain some categories. It describes with little detail what each category is asking.	Worksheet is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking.
Worksheet-Group	Worksheet is completely filled out with clear language for each category. It describes much with great detail what each category is asking. It is clear that all members of the group contributed by differences between individual worksheets to group worksheet or clear collaboration in adding to existing topics.	Worksheet is mostly filled out with understandable language for each category. It describes enough detail to understand what each category is asking. It is evident that most members of the group contributed by small differences between individual worksheets to group worksheet or partial collaboration in addition to existing topics.	Worksheet is partially filled out with some clarity in language to explain some categories. It describes with little detail what each category is asking. It is clear that a small percentage of the group contributed by similarities between some individuals' worksheets and the group worksheet or little to no work as a group finished or completed on worksheet.	Worksheet is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. It is clear that either one person filled out the worksheet without input from the group by identical language from individual worksheet to group worksheet or not work as a group was completed on worksheet.

Rough Drafts	Detailed rough draft of all brainstorms and writing at the end of the unit are turned in and include all required information. Has evidence of feedback and shows improvement in clarity on next draft.	Draft includes most brainstorms and writing at the end of the unit and include most of the information required but may be missing some parts. Has evidence of feedback and minimal improvement in clarity on next draft.	Draft includes very little of the brainstorms and writing at the end of the unit and includes minimal information required. Has little evidence of feedback and limited improvement in clarity on next draft.	Draft is missing most of the draft work for unit; does not include any of the information required and has no evidence of feedback or improvement in clarity on next draft.
Hypothesis	Hypothesis is written clearly with detailed supportive evidence and fully expresses question to be explored during experimentation. Is provable, and feasible.	Hypothesis is written with enough detail to understand meaning with meaningful evidence and expresses question to be explored during experimentation. Is feasible, may not be provable.	Hypothesis is written with limited clarity and shows little evidence with no question to be explored or is not feasible or provable through experimentation.	Hypothesis is written in a manner that does not connect to any evidence and/or is not clear enough to assess whether it is feasible or provable through experimentation.

Research	4	3	2	1
Sources	Has at least three sources accurately documented with details supporting the sources which include but not limited to the website, the name of source, the page	Has at least three sources accurately documented but is missing some details to support the sources such as those mentioned in “4”	Has 2 sources that are accurately documented but are missing most details to support them such as those mentioned in “4”.	Has one or no sources accurately documented and has limited or no supports for the sources given.

	numbers used, the name of the book or journal, etc.			

Procedure	4	3	2	1
Experiment Planning Sheet	Worksheet is completely filled out with clear language for each category. It describes much with great detail what each category is asking. Includes accurate detailed steps to complete procedure and a detailed list of possible variables.	Worksheet is mostly filled out with understandable language for each category. It describes enough detail to understand what each category is asking. Includes accurate steps to complete procedure and a short list of possible variables.	Worksheet is partially filled out with some clarity in language to explain some categories. It describes with little detail what each category is asking. Have vague or unclear steps to complete procedure and little to no possible variables that are not accurate.	Worksheet is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. Does not express steps nor list any variables.
Rough Drafts	Detailed rough draft of all brainstorms and writing at the end of the unit are turned in and include all required information. Has evidence of feedback and shows improvement in clarity on next draft.	Draft includes most brainstorms and writing at the end of the unit and include most of the information required but may be missing some parts. Has evidence of feedback and minimal improvement in clarity on next draft.	Draft includes very little of the brainstorms and writing at the end of the unit and includes minimal information required. Has little evidence of feedback and limited improvement in clarity on next draft.	Draft is missing most of the draft work for unit; does not include any of the information required and has no evidence of feedback or improvement in clarity on next draft.
Final Procedure	Detailed and written in a	Written in a step by step fashion	Written with a format that is not	Written in a format that is

	step by step fashion with sequence of steps in procedure logical to follow. Does not skip steps with no confusion on the part of the reader in how to set up and run experiment.	with a sequence of steps in procedure that can be followed. May skip one step with little confusion on the part of the reader in how to set up and run experiment.	as easily followed but is understandable. May skip steps or provide too much information that causes confusion for the reader to accurately set up and run experiment.	confusing and cannot be followed without explanation by the writer. Is unable to be followed by the reader at all; no description to follow through on setting up or running and experiment.

Collaboration/Group Work	4	3	2	1
Feedback	Oral(Signed) feedback and support as a group was clear and able to be incorporated in discussions among group members. Group members were open to feedback and willing to incorporate new ideas into their own thinking.	Oral(Signed) feedback and supports as a group were mostly clear and able to be incorporated in discussions among group members. Group members were sometimes not open to feedback but willing to move forward as a group.	Oral(signed) feedback and supports as a group were often unclear to one another and unable to be incorporated into work. Group members refused feedback by other members and not willing to change to work as a group or incorporate new ideas from other members of the group.	Oral(Signed) feedback and support as a group were absent and only one or two people took over group dynamic. Group members refused input of any kind and were not willing to incorporate or encourage other members of the group to participate.

Student/Peer Rubric

Hypothesis	4	3	2	1
Worksheet-Individual	I was able to completely fill out the worksheet with clear language for each category. It describes much with great detail what each category is asking.	I was able to mostly fill out the worksheet with understandable language for each category. It describes enough detail to understand what each category is asking.	I was able to partially fill the worksheet out with some clarity in language to explain some categories. It describes with little detail what each category is asking.	I was not able to fill out the worksheet, it is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking.
Worksheet-Group	We were able to completely fill out the worksheet with clear language for each category. It describes much with great detail what each category is asking. It is clear that all members of the group contributed by differences between individual worksheets to group worksheet or clear collaboration in adding to existing topics.	We were able to mostly fill out the worksheet with understandable language for each category. It describes enough detail to understand what each category is asking. It is evident that most members of the group contributed by small differences between individual worksheets to group worksheet or partial collaboration in addition to existing topics.	We were able to partially fill the worksheet out with some clarity in language to explain some categories. It describes with little detail what each category is asking. It is clear that a small percentage of the group contributed by similarities between some individuals' worksheets and the group worksheet or little to no work as a group finished or completed on worksheet.	We were not able to fill out the worksheet, it is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. It is clear that either one person filled out the worksheet without input from the group by identical language from individual worksheet to group worksheet or not work as a group was completed on worksheet.

Rough Drafts	Detailed rough draft of all brainstorms and writing at the end of the unit are turned in and include all required information. Has evidence of feedback and shows improvement in clarity on next draft.	Draft includes most brainstorms and writing at the end of the unit and include most of the information required but may be missing some parts. Has evidence of feedback and minimal improvement in clarity on next draft.	Draft includes very little of the brainstorms and writing at the end of the unit and includes minimal information required. Has little evidence of feedback and limited improvement in clarity on next draft.	Draft is missing most of the draft work for unit; does not include any of the information required and has no evidence of feedback or improvement in clarity on next draft.
Hypothesis	Hypothesis is written clearly with detailed supportive evidence and fully expresses question to be explored during experimentation. Is provable, and feasible.	Hypothesis is written with enough detail to understand meaning with meaningful evidence and expresses question to be explored during experimentation. Is feasible, may not be provable.	Hypothesis is written with limited clarity and shows little evidence with no question to be explored or is not feasible or provable through experimentation.	Hypothesis is written in a manner that does not connect to any evidence and/or is not clear enough to assess whether it is feasible or provable through experimentation.

Collaboration/Group Work	4	3	2	1
Feedback	I felt that my group, as a whole was able to give Oral(Signed) feedback and support as a group that was very clear and	I felt that my group, was a whole was mostly able to give Oral(Signed) feedback and support as a group. This	I felt that my group was not very clear in giving Oral(signed) feedback and support as a group. The feedback and	I felt that my group was not supportive or able to collaborate at all. Only one or two people took over

	open. I felt other group members were open to feedback and willing to incorporate new ideas into our project.	feedback and support was mostly clear and open. I felt other group members were somewhat open to feedback and willing to incorporate new ideas into our project.	support was often unclear to one another and unable to be incorporated into work. I felt that other group members refused feedback and not willing to change to work as a group or incorporate new ideas into our project.	group. These group members refused input of any kind and were not willing to incorporate or encourage other members of the group to participate.

Unit B

Teacher Rubric

Procedure and Data	4	3	2	1
Worksheet-Procedure(Group)	Worksheet is completely filled out with clear language for each category. It describes much with great detail what each category is asking. It is clear that all members of the group contributed by	Worksheet is mostly filled out with understandable language for each category. It describes enough detail to understand what each category is asking. It is evident that most members of the group	Worksheet is partially filled out with some clarity in language to explain some categories. It describes with little detail what each category is asking. It is clear that a small percentage of	Worksheet is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. It is clear that either one person filled out the worksheet

	differences between individual worksheets to group worksheet or clear collaboration in adding to existing topics.	contributed by small differences between individual worksheets to group worksheet or partial collaboration in addition to existing topics.	the group contributed by similarities between some individuals' worksheets and the group worksheet or little to no work as a group finished or completed on worksheet.	without input from the group by identical language from individual worksheet to group worksheet or not work as a group was completed on worksheet.
Worksheet-Data(Group)	Worksheet is completely filled out with clear language for each category. It describes much with great detail what each category is asking. It is clear that all members of the group contributed by differences between individual worksheets to group worksheet or clear collaboration in adding to existing topics.	Worksheet is mostly filled out with understandable language for each category. It describes enough detail to understand what each category is asking. It is evident that most members of the group contributed by small differences between individual worksheets to group worksheet or partial collaboration in addition to existing topics.	Worksheet is partially filled out with some clarity in language to explain some categories. It describes with little detail what each category is asking. It is clear that a small percentage of the group contributed by similarities between some individuals' worksheets and the group worksheet or little to no work as a group finished or completed on worksheet.	Worksheet is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. It is clear that either one person filled out the worksheet without input from the group by identical language from individual worksheet to group worksheet or not work as a group was completed on worksheet.
Materials	Materials are chosen and explained for their use within	Materials are chosen and mostly explained what	Materials are not chosen by the group, but extensive	Group does not use materials appropriately and/or refuses

	the experiment. They are written down as part of the list of materials including quantity and are included in the procedure.	they will be used for within the experiment. They are mostly written down, or added during the course of the experiment.	support was given on the part of the teacher to chose and use materials. They are written down, but some are missing quantities or their use is unclear in the experiment.	to use materials provided.
Procedure	Procedure is written in a very clear step by step manner with all materials listed as part of the process. Transition from rough draft to final draft has important changes given by peer feedback which enhance the understanding of the procedure.	Procedure is written with mostly clear step by step processes in which most of the materials are listed. Transition from rough draft to final draft has some changes which allow for better understanding of the procedure.	Procedure is somewhat clear, has a step by step process that is missing some information or does not give clear materials used in the process. Transition from rough to final draft shows little to no changes and does not help in understanding.	Procedure is not clear and/or has not materials to be used during the process. It is missing any information with which to actually do the procedure. There does not appear to be any improvement or incorporation of peer feedback from rough to final draft.
Variables and Controls	Variables and Controls are discussed and written appropriately within the worksheet.	Variables and Controls are discussed and written with less clarity than a score of 4.	Variables and Controls are not discussed or absent from the worksheet.	Variables and Controls are not discussed AND absent from the worksheet.
Data	Data is clearly written down onto one of the	Data is mostly clear in the documentation	Data is somewhat clear in the	Data is not clearly written down on either

	given worksheets, or student has created their own recording sheet. The data are analyzed and there are clear conclusions made about the data.	on the given worksheet or the student created recording sheet. The data are somewhat analyzed and there are some conclusions made about the data.	documentation on the given worksheet or the student created worksheet. The data are minimally analyzed and there is minimal conclusions made about the data.	a given or student made worksheet. There is no analysis to the data nor any conclusions made.
Graph(s)/Graphics	Graphs/Graphics are present and clear in depictions relating to the experiment. They show either data or procedure with descriptions or labels.	Graphs/Graphics are present and mostly clear in depictions relating to the experiment. They show either data or procedure with some descriptions or labels.	Graphs/Graphics are present and somewhat clear in depictions relating to the experiment. They show either data or procedure with minimal descriptions or labels.	Graphs/Graphics are absent or copied from another source without relation to the experiment. They do not show data or procedure.

Collaboration/Group Work	4	3	2	1
Feedback	Oral(Signed) feedback and support as a group was clear and able to be incorporated in discussions among group members. Group members were open to feedback and	Oral(Signed) feedback and supports as a group were mostly clear and able to be incorporated in discussions among group members. Group members were sometimes not open to	Oral(signed) feedback and supports as a group were often unclear to one another and unable to be incorporated into work. Group members refused feedback by	Oral(Signed) feedback and support as a group were absent and only one or two people took over group dynamic. Group members refused input of any kind

	willing to incorporate new ideas into their own thinking.	feedback but willing to move forward as a group.	other members and not willing to change to work as a group or incorporate new ideas from other members of the group.	and were not willing to incorporate or encourage other members of the group to participate.

Student/Peer Rubric

Procedure and Data	4	3	2	1
Worksheet-Procedure(Group)	We were able to completely fill out the worksheet with clear language for each category. It describes much with great detail what each category is asking. It is clear that all members of the group contributed by differences between individual worksheets to group worksheet or clear collaboration in adding to existing topics.	We were able to mostly fill out the worksheet with understandable language for each category. It describes enough detail to understand what each category is asking. It is evident that most members of the group contributed by small differences between individual worksheets to group worksheet or partial collaboration in	We were able to partially fill the worksheet out with some clarity in language to explain some categories. It describes with little detail what each category is asking. It is clear that a small percentage of the group contributed by similarities between some individuals' worksheets and the group worksheet or little to no work as a	We were not able to fill out the worksheet, it is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. It is clear that either one person filled out the worksheet without input from the group by identical language from individual worksheet to group worksheet or not work as a

		addition to existing topics.	group finished or completed on worksheet.	group was completed on worksheet.
Worksheet-Data(Group)	We were able to completely fill out the worksheet with clear language for each category. It describes much with great detail what each category is asking. It is clear that all members of the group contributed by differences between individual worksheets to group worksheet or clear collaboration in adding to existing topics.	We were able to mostly fill out the worksheet with understandable language for each category. It describes enough detail to understand what each category is asking. It is evident that most members of the group contributed by small differences between individual worksheets to group worksheet or partial collaboration in addition to existing topics.	We were able to partially fill the worksheet out with some clarity in language to explain some categories. It describes with little detail what each category is asking. It is clear that a small percentage of the group contributed by similarities between some individuals' worksheets and the group worksheet or little to no work as a group finished or completed on worksheet.	We were not able to fill out the worksheet, it is almost empty with no clarity or explanation for each category. It uses lists or single words to describe what each category is asking. It is clear that either one person filled out the worksheet without input from the group by identical language from individual worksheet to group worksheet or not work as a group was completed on worksheet.
Materials	Materials are chosen and explained for their use within the experiment. They are written down as part of the list of materials including quantity and are included in the procedure.	Materials are chosen and mostly explained what they will be used for within the experiment. They are mostly written down, or added during the course of the experiment.	Materials are not chosen by the group, but extensive support was given on the part of the teacher to chose and use materials. They are written down, but some are	Group does not use materials appropriately and/or refuses to use materials provided.

			missing quantities or their use is unclear in the experiment.	
Procedure	Procedure is written in a very clear step by step manner with all materials listed as part of the process. Transition from rough draft to final draft has important changes given by peer feedback which enhance the understanding of the procedure.	Procedure is written with mostly clear step by step processes in which most of the materials are listed. Transition from rough draft to final draft has some changes which allow for better understanding of the procedure.	Procedure is somewhat clear, has a step by step process that is missing some information or does not give clear materials used in the process. Transition from rough to final draft shows little to no changes and does not help in understanding.	Procedure is not clear and/or has not materials to be used during the process. It is missing any information with which to actually do the procedure. There does not appear to be any improvement or incorporation of peer feedback from rough to final draft.
Variables and Controls	Variables and Controls are discussed and written appropriately within the worksheet.	Variables and Controls are discussed and written with less clarity than a score of 4.	Variables and Controls are not discussed or absent from the worksheet.	Variables and Controls are not discussed AND absent from the worksheet.
Data	Data is clearly written down onto one of the given worksheets, or student has created their own recording sheet. The data are analyzed and there are clear	Data is mostly clear in the documentation on the given worksheet or the student created recording sheet. The data are somewhat analyzed and there are some	Data is somewhat clear in the documentation on the given worksheet or the student created worksheet. The data are minimally analyzed and	Data is not clearly written down on either a given or student made worksheet. There is no analysis to the data nor any conclusions made.

	conclusions made about the data.	conclusions made about the data.	there is minimal conclusions made about the data.	
Graph(s)/Graphics	Graphs/Graphics are present and clear in depictions relating to the experiment. They show either data or procedure with descriptions or labels.	Graphs/Graphics are present and mostly clear in depictions relating to the experiment. They show either data or procedure with some descriptions or labels.	Graphs/Graphics are present and somewhat clear in depictions relating to the experiment. They show either data or procedure with minimal descriptions or labels.	Graphs/Graphics are absent or copied from another source without relation to the experiment. They do not show data or procedure.

Collaboration/Group Work	4	3	2	1
Feedback	I felt that my group, as a whole was able to give Oral(Signed) feedback and support as a group that was very clear and open. I felt other group members were open to feedback and willing to incorporate new ideas into our project.	I felt that my group, was a whole was mostly able to give Oral(Signed) feedback and support as a group. This feedback and support was mostly clear and open. I felt other group members were somewhat open to feedback and willing to incorporate new ideas into our project.	I felt that my group was not very clear in giving Oral(signed) feedback and support as a group. The feedback and support was often unclear to one another and unable to be incorporated into work. I felt that other group members refused feedback and not willing to change to	I felt that my group was not supportive or able to collaborate at all. Only one or two people took over group. These group members refused input of any kind and were not willing to incorporate or encourage other members of the group to participate.

			work as a group or incorporate new ideas into our project.	

Unit C

Teacher Final Rubric

Final Paper	4	3	2	1
Introduction	Introduction has three parts: an Introductory Paragraph, a Scientific Concept Paragraph, and a Historical Paragraph. The introduction has clear evidence from research done about the concept. The introduction clearly presents the concept to the reader.	Introduction has three parts: an Introductory Paragraph, a Scientific Concept Paragraph, and a Historical Paragraph. The introduction has some evidence from research done about the concept. The introduction presents the concept to the reader.	Introduction has three parts: an Introductory Paragraph, a Scientific Concept Paragraph, and a Historical Paragraph. The introduction has limited evidence from research done about the concept. The introduction is not clear about the concept to the reader.	Introduction has one or more parts missing. The introduction has no or limited evidence from research done about the concept. The introduction is not clear.
Hypothesis	Hypothesis is written clearly with detailed supportive evidence and fully expresses question to be explored during experimentation. Is provable, and feasible.	Hypothesis is written with enough detail to understand meaning with meaningful evidence and expresses question to be explored during experimentation. Is feasible, may not be	Hypothesis is written with limited clarity and shows little evidence with no question to be explored or is not feasible or provable through experimentation.	Hypothesis is written in a manner that does not connect to any evidence and/or is not clear enough to assess whether it is feasible or provable through experimentation.

		provable.		
Materials	Materials are chosen and explained for their use within the experiment. They are written down as part of the list of materials including quantity and are included in the procedure.	Materials are chosen and mostly explained what they will be used for within the experiment. They are mostly written down, or added during the course of the experiment.	Materials are not chosen by the group, but extensive support was given on the part of the teacher to chose and use materials. They are written down, but some are missing quantities or their use is unclear in the experiment.	Group does not use materials appropriately and/or refuses to use materials provided.
Procedure	Procedure is written in a very clear step by step manner with all materials listed as part of the process. Transition from rough draft to final draft has important changes given by peer feedback which enhance the understanding of the procedure.	Procedure is written with mostly clear step by step processes in which most of the materials are listed. Transition from rough draft to final draft has some changes which allow for better understanding of the procedure.	Procedure is somewhat clear, has a step by step process that is missing some information or does not give clear materials used in the process. Transition from rough to final draft shows little to no changes and does not help in understanding.	Procedure is not clear and/or has not materials to be used during the process. It is missing any information with which to actually do the procedure. There does not appear to be any improvement or incorporation of peer feedback from rough to final draft.
Variables and Controls	Variables and Controls are discussed and written appropriately	Variables and Controls are discussed and written with less clarity than	Variables and Controls are not discussed or absent from the worksheet.	Variables and Controls are not discussed AND absent from the

	within the worksheet.	a score of 4.		worksheet.
Data	Data is clearly written down onto one of the given worksheets, or student has created their own recording sheet. The data are analyzed and there are clear conclusions made about the data.	Data is mostly clear in the documentation on the given worksheet or the student created recording sheet. The data are somewhat analyzed and there are some conclusions made about the data.	Data is somewhat clear in the documentation on the given worksheet or the student created worksheet. The data are minimally analyzed and there is minimal conclusions made about the data.	Data is not clearly written down on either a given or student made worksheet. There is no analysis to the data nor any conclusions made.
Graph(s)/Graphics	Graphs/Graphics are present and clear in depictions relating to the experiment. They show either data or procedure with descriptions or labels.	Graphs/Graphics are present and mostly clear in depictions relating to the experiment. They show either data or procedure with some descriptions or labels.	Graphs/Graphics are present and somewhat clear in depictions relating to the experiment. They show either data or procedure with minimal descriptions or labels.	Graphs/Graphics are absent or copied from another source without relation to the experiment. They do not show data or procedure.
Results	Results are written in a clear manner that shows student data sheets and how they analyzed them.	Results are written in a mostly clear form and shows student data sheets and how they attempted to analyze them.	Results are written somewhat clearly and shows some student data, analysis may be missing.	Results are unclear or missing. Student has no or very little data. There is no analysis.
Conclusion	Conclusion is written clearly with student reflection and	Conclusion is written with mostly clear language with	Conclusion is written somewhat clearly with	Conclusion is not clear and/or missing information

	reactions to what was learned or what happened during the scientific process.	student reflection and reactions to what was learned or what happened during the scientific process.	student reflection and reactions to what was learned or what happened during the scientific process.	with no or little reflection about the scientific process.
Bibliography	Has at three or more appropriately written references from the internet, books, or textbook.	Has exactly three written references with most information from the internet, books, or textbook.	Has less than three references from only once source, i.e. only from internet, only from textbook.	Has no references.

Final Presentation	4	3	2	1
Composure	The student maintained a professional, focused attitude throughout the entire presentation from self introduction to conclusion/Q and A.	The students maintained a professional, focused attitude throughout most of the presentation from self introduction to conclusion/Q and A.	The student maintained a professional, focused attitude throughout some of the presentation from self introduction to conclusion/Q and A.	The student was not able to maintain a professional, focused attitude or did for a minimal amount of time during the presentation.
Introduction(of self)	The student introduced themselves by first, last name, sign name, and title of the project including the names of students they worked with.	The students introduced themselves by first name, last name and mentioned the concept(not title) of project and the other students they worked with.	The student introduced themselves by sign name or first name only, mentioned the concept(not title) of project and did not mention other students they worked with.	The student did not introduce themselves.
Speakers Notes	The student	The student	The student	The student

	used a small amount or no notes of reference and was able to articulate their thoughts clearly.	used a small amount or no notes of reference and was able to articulate their thoughts pretty clearly.	used a large amount of notes but was able to articulate their thoughts clearly	relied heavily on notes to the point of not being clear in their presentation, or no notes were present and the student read from their project.

Student Self Reflection Rubric

Final Paper	4	3	2	1
Introduction	Introduction has three parts: an Introductory Paragraph, a Scientific Concept Paragraph, and a Historical Paragraph. The introduction has clear evidence from research done about the concept. The introduction clearly presents the concept to the reader.	Introduction has three parts: an Introductory Paragraph, a Scientific Concept Paragraph, and a Historical Paragraph. The introduction has some evidence from research done about the concept. The introduction presents the concept to the reader.	Introduction has three parts: an Introductory Paragraph, a Scientific Concept Paragraph, and a Historical Paragraph. The introduction has limited evidence from research done about the concept. The introduction is not clear about the concept to the reader.	Introduction has one or more parts missing. The introduction has no or limited evidence from research done about the concept. The introduction is not clear.
Hypothesis	Hypothesis is written clearly with detailed supportive evidence and fully expresses question to be explored during experimentatio	Hypothesis is written with enough detail to understand meaning with meaningful evidence and expresses question to be explored	Hypothesis is written with limited clarity and shows little evidence with no question to be explored or is not feasible or provable through	Hypothesis is written in a manner that does not connect to any evidence and/or is not clear enough to assess whether it is feasible or

	n. Is provable, and feasible.	during experimentation. Is feasible, may not be provable.	experimentation.	provable through experimentation.
Materials	Materials are chosen and explained for their use within the experiment. They are written down as part of the list of materials including quantity and are included in the procedure.	Materials are chosen and mostly explained what they will be used for within the experiment. They are mostly written down, or added during the course of the experiment.	Materials are not chosen by the group, but extensive support was given on the part of the teacher to chose and use materials. They are written down, but some are missing quantities or their use is unclear in the experiment.	Group does not use materials appropriately and/or refuses to use materials provided.
Procedure	Procedure is written in a very clear step by step manner with all materials listed as part of the process. Transition from rough draft to final draft has important changes given by peer feedback which enhance the understanding of the procedure.	Procedure is written with mostly clear step by step processes in which most of the materials are listed. Transition from rough draft to final draft has some changes which allow for better understanding of the procedure.	Procedure is somewhat clear, has a step by step process that is missing some information or does not give clear materials used in the process. Transition from rough to final draft shows little to no changes and does not help in understanding.	Procedure is not clear and/or has not materials to be used during the process. It is missing any information with which to actually do the procedure. There does not appear to be any improvement or incorporation of peer feedback from rough to final draft.
Variables and	Variables and	Variables and	Variables and	Variables and

Controls	Controls are discussed and written appropriately within the worksheet.	Controls are discussed and written with less clarity than a score of 4.	Controls are not discussed or absent from the worksheet.	Controls are not discussed AND absent from the worksheet.
Data	Data is clearly written down onto one of the given worksheets, or student has created their own recording sheet. The data are analyzed and there are clear conclusions made about the data.	Data is mostly clear in the documentation on the given worksheet or the student created recording sheet. The data are somewhat analyzed and there are some conclusions made about the data.	Data is somewhat clear in the documentation on the given worksheet or the student created worksheet. The data are minimally analyzed and there is minimal conclusions made about the data.	Data is not clearly written down on either a given or student made worksheet. There is no analysis to the data nor any conclusions made.
Graph(s)/Graphics	Graphs/Graphics are present and clear in depictions relating to the experiment. They show either data or procedure with descriptions or labels.	Graphs/Graphics are present and mostly clear in depictions relating to the experiment. They show either data or procedure with some descriptions or labels.	Graphs/Graphics are present and somewhat clear in depictions relating to the experiment. They show either data or procedure with minimal descriptions or labels.	Graphs/Graphics are absent or copied from another source without relation to the experiment. They do not show data or procedure.
Results	Results are written in a clear manner that shows student data sheets and how they analyzed them.	Results are written in a mostly clear form and shows student data sheets and how they attempted to analyze them.	Results are written somewhat clearly and shows some student data, analysis may be missing.	Results are unclear or missing. Student has no or very little data. There is no analysis.

Conclusion	Conclusion is written clearly with student reflection and reactions to what was learned or what happened during the scientific process.	Conclusion is written with mostly clear language with student reflection and reactions to what was learned or what happened during the scientific process.	Conclusion is written somewhat clearly with student reflection and reactions to what was learned or what happened during the scientific process.	Conclusion is not clear and/or missing information with no or little reflection about the scientific process.
Bibliography	Has at three or more appropriately written references from the internet, books, or textbook.	Has exactly three written references with most information from the internet, books, or textbook.	Has less than three references from only once source, i.e. only from internet, only from textbook.	Has no references.

Collaboration(Self)	4	3	2	1
Working in a group	I, as a group member was able to work well among the group and felt valued as a group member.	I, as a group member was able to work mostly well among the group and felt mostly valued as a group member.	I, as a group member was somewhat able to do work among the group and felt somewhat valued as a group member.	I, as a group member was not able to work within my group and/or did not feel valued as a group member.
Individual contribution	I felt that I contributed significantly to the group.	I felt that I contributed a good amount to the group.	I felt that I contributed some to the group.	I felt that I did not contribute to the group.
Solving group conflict	I felt that I was able to easily solve group conflict.	I felt that I was able to mostly solve group conflict.	I felt that I was somewhat able to solve group	I felt that I was not able to solve group conflict.

			conflict.	
Expressing Opinion	I felt that my opinion was valued and taken into consideration among the group.	I felt that my opinion was mostly valued and taken into consideration among the group.	I felt that my opinion was somewhat valued and sometimes taken into account among the group.	I felt that I could not express my opinion and/or that my opinion was never taken into account among the group.

Collaboration(Group)	4	3	2	1
Working Together	I felt that my group, as a whole was able to give Oral(Signed) feedback and support as a group that was very clear and open. I felt other group members were open to feedback and willing to incorporate new ideas into our project.	I felt that my group, was a whole was mostly able to give Oral(Signed) feedback and support as a group. This feedback and support was mostly clear and open. I felt other group members were somewhat open to feedback and willing to incorporate new ideas into our project.	I felt that my group was not very clear in giving Oral(signed) feedback and support as a group. The feedback and support was often unclear to one another and unable to be incorporated into work. I felt that other group members refused feedback and not willing to change to work as a group or incorporate new ideas into our project.	I felt that my group was not supportive or able to collaborate at all. Only one or two people took over group. These group members refused input of any kind and were not willing to incorporate or encourage other members of the group to participate.
Solving problems	I felt that my	I felt that my	I felt that my	I felt that my

	group, as a whole was able to solve problems by being open and willing to compromise and work together most of the time.	group, as a whole was able to solve most problems by being open and willing to compromise some of the time.	group, as a whole, was somewhat able to solve problems by being somewhat open and willing compromise some of the time.	group, as a whole was not able to solve problems. Often people within the group were closed or unwilling to compromise.
Communication	I felt that my group had excellent communication among group members.	I felt that my group had good communication among group members.	I felt that my group had ok communication among group members	I felt that my group had poor communication among group members.