Renaissance Teacher Work Sample Consortium

A Teacher Work Sample Exemplar

Submitted by: University of Northern Iowa

Grade Level: 11th

Subject: Chemistry

Topic: Energy Transfer Motion, Enthalpy Change, Inquiry Learning, Experimentation

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Teacher Work Sample Spring 2008
11th Grade Chemistry

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1. Contextual Factors

Community

My student teaching experience was completed in an industrial town in Northern Tanzania, in Sub-Saharan Eastern Africa. The town is on the lower slopes of Mt. Kilimanjaro, which is the tallest point in Africa and one of the most common destinations of tourists to Africa. Because of this attraction, the town has grown considerably in recent decades and is full of many little shops, hotels, safari travel agencies and factories. The downtown area has a lot of hustle and bustle. The town has a population of about 140,000, and is relatively modern.

Though Tanzania is one of the poorest countries in the world by average income, this area is one of the better-off regions of the country. The national income per capita is less than one thousand dollars. In Tanzania, about 1/3 of the population is Christian, 1/3 Muslim, and 1/3 other religions and tribal beliefs. This town has mosques, temples and churches. Though the majority of people are not happy with the political party that has been in power since independence, the political climate and tribal relations are stable, and very safe relative to the rest of the region of the continent.

My school is the only international school in the town. However, there are many other primary and secondary schools in this town, some in English medium and some in Kiswahili medium, and education is important in the community. This town has the largest per capita concentration of secondary schools in all of the country.

District

The “district” that my school belongs to is the community made up of two campuses. They are “one school with two campuses.” The other campus is about an hours drive from my campus. The two campuses are considered one school, and work very closely to maintain internal moderation and similar leadership. Counsels of administrators meet biweekly from the two campuses to plan curriculum and manage the schools. The school is a private school and is fully funded by student tuition. The fees increase as students progress from primary to secondary, with Diploma (secondary) boarding students paying about $25,000 a year.

My campus is a boarding school, and has primary, middle, and secondary students on the same grounds. The other campus is a day school offering primary and middle school education. At the start of the school year, the two campuses had a total enrollment of 393 students, and a full-time faculty of 49 teachers and administrators. 75 percent of the student population is second language English speakers. There are 42 different nationalities represented by the student body, and thus no real minority. The majority of students are Tanzanian, representing 22 percent of the body. Most students come from families of local business people, expatriates working with the UN or other businesses, medical personnel or missionaries. Teachers are British, Canadian, American, Tanzanian, and other nationalities.

School

The campus in this town has a long history and tradition in the community. It was the first school in Africa to adopt the International Baccalaureate (IB) Diploma program, in 1969. In the last decade, the school has seen a 90 percent success rate on the IB Diploma examinations, and 85 percent of the graduates go to university in the USA, the UK, or elsewhere. The school offers Pre K-12 education on one campus. Classrooms, recreational areas, dining halls and boarding are all located on the school grounds. The school has an enrollment of 200 students. About 75 percent of the students are not first language English speakers, and the school provides language assistance for incoming students. There is one full-time ESL teacher on campus. All students are included in the general education classrooms. As part of the IB curriculum, students are required to participate in CAS (Creative, Action, Service) activities every week, including the options of cookery, choir, model UN, teaching swimming lessons to younger students, and building programs and workshops in the community. There are many extra-curricular activities for students to choose from. The mission statement of the school is to "inspire individuals to be lifelong learners in a global community," which I think is a very accurate description of what happens here because the school itself is a global community.

Classroom

There are three science classrooms, home to all science classes from 6^{th} grade to 12^{th} grade. There are two small offices in between classrooms, and a small stockroom of chemicals. There are four science teachers, and two lab technicians. My classroom is the chemistry classroom. In many ways it is a typical science room. A very old fume hood, sinks, and gas valves are located along the side counters. There are lab coats and safety glasses in the back. Under the side counters are drawers of equipment and supplementary materials, such as data tables and booklets. There is a shelf of relatively new and old textbooks at the front of the room and in a cabinet in the back. The classroom is shared between two teachers; one of chemistry and one of environmental science. The counters are used as lab benches during lab activities. The tables are situated in the middle of the room, facing front, with two students to a table. The maximum number of students that the tables in the room could hold is 18. The students' chairs are actually tall stools with no back support, and they are uncomfortable. One **instructional implication** of the chairs is that students cannot and should not sit in their chairs for extended periods of time because they get uncomfortable. Movement and interaction, lab activities and participation should be integrated into every lesson. I should not spend a whole class lecturing. Between the students and the white board at the front of the classroom is a long teacher's desk.

The stockroom of chemicals is very small and limited. An **instructional implication** of this limitation means that I will have to be creative, ask the students to be creative, and do demonstrations sometimes rather than full class activities. This works well with inquiry based science teaching, as I can ask the students to design their own explorations and experiments based on what is available.

There are currently no laboratory safety rules or classroom rules posted on the walls. There are only a few science related posters. The twelve characteristics that the school has advocated students to strive to maintain are posted high up on the wall, and these can be motivating or referred to if students are misbehaving. There is no separation between the "classroom" and the "laboratory." Students use the side counters during labs, but are constantly squishing and trying to make their way around the tables. An **instructional implication** of the smallness of the room is that I will encourage the students to be well organized while performing labs, and to be extra aware of safety.

Student Characteristics

I have chosen the D1 (Diploma first year, 11th grade) chemistry class to focus upon for my TWS project. There are twelve students in this class, consisting of three females and nine males. Ten students are from Tanzania, one student is Kenyan, and one student is British. There are no Caucasian students and seven students are of Indian ethnicity. The students range in age from 16-18 years old. Seven of the students are boarding students and five are day students, spending their evenings and nights at home. One **instructional implication** of this is that the boarding students have a very different after-school life than non-boarders. Their evening is booked with activities and designated study times. Non-boarders can spend their evenings how they or their parents decide. I will have to be decisive in the home work allotted to the boarding students and what is given to the day students.

Because the school is a private school and is very expensive, most of the students come from wealthy families. Three students are scholarship winners from local secondary schools. They have a very different educational background than many of the other students. The local secondary schools often have fifty or more students in a classroom and students are sometimes struck if they speak out of turn. An important **implication** of this is that the scholarship students are very quiet in the classroom, even though they often seem to have an answer or a question. I need to be sure to actively be aware of them and call on these students, and make them feel comfortable to share their thoughts.

To get to know the students better, on one of the first days with the class, I handed out a questionnaire asking the students to answer some questions about themselves. Then I shared my answers with them.

Student Skills

I will discuss three students in particular from the class. Student X is a scholarship winner from a local school. This is his first year here at this school. He has led a difficult life for a young man, though he says that you will always see him smiling. He is a proud Tanzanian, and he wants to be a political leader and help the "poor dying and innocent Africans." Student X is very motivated and is at the top of the class overall. He is also a very curious student and will often ask questions ahead of the rest of the class. He is generally quiet and soft-spoken in class, coming from a local school, though his questions are typically thoughtful and cognitively high level.

Student Y is a very pleasant young man, though not entirely interested in chemistry. His family is from India; he was born in London, and is now living in this town in Tanzania. He is a very good rock guitarist and performs magic tricks, and he seems to be very popular. He is more interested in studying the effects of mind-altering plants (second-hand, of course; an essay topic he chose) and other things than reading chemistry. He is entirely capable of performing well, according to my cooperating teacher. So far this year, however, Student Y has been consistently near the bottom of the class and does not show a great desire to change that.

Student Z is a kind, sweet and happy female in the class. She lives with her parents and grandfather and her family is very important to her. She enjoys sports and plays music, and she has modest dreams of studying in England someday. She is very much a normal teenager. She is very attentive and focused in class and participates very well, though she gets nervous on tests and quizzes. Student Z is well organized and motivated, but she just does not seem to have a natural inclination toward chemistry, and she is performing at about the middle of the class.

An **instructional implication** of these student skills is that activities and lab experiments will be good for this class. Student X is mostly self-taught by books, and labs will be excellent opportunities for him to be challenged and have first-hand experience with science. Student Y will be more motivated to participate in something that gets him out of his seat with a lab coat on. And Student Z will have the opportunity to show what she knows and what she can do through the mode of experimentation, rather than tests. Another **instructional implication** to keep in mind is that not all of the students have the same chemistry skills. Though they chose to take chemistry, not all of the students love chemistry or get excited about learning chemistry, and I will want to make activities and situations for the students to make connections to their many other interests.

2. Learning Goals

Learning Goal 1 (LG1): Students will be able to design and carry out calorimetry experiments

Alignment with standards:

National Science Education Standards

Content Standard A: Science As Inquiry, grades 9-12

- Develop abilities necessary to do scientific inquiry
- Design and conduct scientific investigations
- Develop understandings about scientific inquiry

Content Standard B: Physical Science, grades 9-12

Chemical Reactions

- Chemical reactions occur all around us
- Chemical reactions may release or consume energy, in the form of heat or light

Conservation of Energy and the Increase in Disorder

- The total energy of the universe is constant. Energy can be transferred but not destroyed
- In all energy transfers the overall effect is that the energy is spread out uniformly

Content Standard C: Life Science, grades 9-12

Matter, Energy, and Organization in Living Systems

- The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed

Content Standard E: Science and Technology, grades 9-12

- Propose designs and choose between alternative solutions
- Develop an understanding that creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

Benchmarks of Science Literacy (from Project 2061)

1B. The Nature of Science: Scientific Inquiry, grades 9-12

Investigations are conducted for different reasons, including exploring new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.

4D: The Physical Setting: The Structure of Matter, grades 9-12

Atoms often join with one another in various combinations in distinct molecules or in repeating three-dimensional crystal patterns. An enormous variety of biological, chemical, and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.

4E: The Physical Setting: Energy Transformations, grades 9-12

Whenever the amount of energy in one place or form diminishes the amount in other places or forms increases by the same amount.

Transformations of energy usually produce some energy in the form of heat, which spreads around by radiation or conduction into cooler places. Although just as much total energy remains, its being spread out more evenly means less can be done with it.

Levels of Bloom's Taxonomy:
Application: Students will **apply** their knowledge of heat transfer, energy transfer, and chemical equations to laboratory practicals and problem solving.

Analysis: Students will **experiment** and **explore** the transfers of heat.

Synthesis: Students will **design**, **plan** and carry out their own experiments.

Appropriateness:
LG1 is appropriate at this stage in the course. The students have spent considerable time in the laboratory, and are motivated, inquisitive, and susceptible to inquiry. If given an idea to explore, students should demonstrate initiative. This is inquiry learning. The students have previously compared and contrasted exothermic and endothermic reactions, and should be able to describe what happens to a system and the surroundings in each type of reaction. LG1 is aligned mostly with standards concerned with the concepts of energy and inquiry.

Learning Goal 2 (LG2): Students will be able to define the standard enthalpy change of formation and apply it to solving problems

Alignment with standards:
National Science Education Standards
Content Standard B: The Physical World, grades 9-12
Structure and Properties of Matter

- A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. A compound is formed when two or more kinds of atoms bind together chemically.
- The physical properties of compounds reflect the nature of the interactions among its molecules.

Chemical Reactions

- Chemical reactions may consume or release energy.

Benchmarks of Science Literacy (from Project 2061)
4E: The Physical World: Energy Transformations, grades 9-12
Whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount.

Levels of Bloom's Taxonomy:
Knowledge: **Define** the term.

Application: **Interpret** when to **apply** standard enthalpy changes of formation to solve problems.

Appropriateness:

The standard enthalpy change of formation (the enthalpy required to form one mole of a substance from its elements in their standard states) is very useful information when solving enthalpy reactions. For this case, it is imperative that students be able to define the term and to quickly and effortlessly be able to apply it to problem solving.

Students are familiar with elements and with the concept of standard states. STP, standard temperature and pressure, was introduced to the students in their chemistry course last year.

Learning Goal 3 (LG3): Students will determine the enthalpy change of reactions using five different methods.

Alignment with standards:
National Science Education Standards
Content Standard B: Physical Science, grades 9-12
Structure and Properties of Matter

- Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together.

Chemical Reactions

- Chemical reactions occur all around us
- Chemical reactions may release or consume energy, in the form of heat or light

Conservation of Energy and the Increase in Disorder

- The total energy of the universe is constant. Energy can be transferred but not destroyed
- In all energy transfers the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.

Content Standard G: History and Nature of Science, grades 9-12
Nature of Scientific Knowledge

- Scientific explanations must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied.

- The core ideas of science such as the conservation of energy or the laws of motion have been subjected to a wide variety of confirmations and are therefore unlikely to change in the areas in which they have been tested.

Benchmarks of Science Literacy (from Project 2061)
1A: The Nature of Science: The Scientific World View, grades 9-12
Scientists assume that the universe is a vast single system in which the basic rules are the same everywhere.

4D: The Physical World: The Structure of Matter, grades 9-12
Atoms often join with one another in various combinations in distinct molecules or in repeating three-dimensional crystal pattern.

4E: The Physical World: Energy Transformations, grades 9-12
Whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount.
Transformations of energy usually produce some energy in the form of heat, which spreads around by radiation or conduction to cooler places.
Some changes of configuration require an input of energy whereas others release energy.

12A: Habits of Mind: Values and Attitudes, grades 9-12
Know why curiosity, honesty, openness, and skepticism are so highly regarded in science and how they are incorporated into the way science is carried out; exhibit those traits in their own lives and value them in others.

12B: Habits of Mind: Computation and Estimation grades 9-12
Use ratios and proportions, including constant rates, in appropriate problems.
Find answers to problems by substituting numerical values in algebraic formulas and judge whether the answer is reasonable by reviewing the process and checking that against typical values.

Levels of Bloom's Taxonomy:
Comprehension: Students will be able to **classify** differing types of enthalpy changes

Application: Students will **choose** appropriate methods and **solve** problems

Analysis: Students will perform **calculations**.

Evaluation: Students will **compare** their solutions with theoretical or experimental values and **evaluate** why there might be differences.

Appropriateness:
There are multiple ways to determine the enthalpy (heat) exchange in a given reaction.

The best method to use can be determined by what type of information is given. Being able to discern when to use different methods is a very important problem solving skill. Not only are the students determining physical properties of chemicals and reactions, they are logically thinking their way through a problem for the best process.

Involved in this learning goal is a good amount of mathematics calculations. The students have all had the appropriate years of mathematics class and are familiar with the common algebra needed, so I do not anticipate any problems with the math. This learning goal is appropriate yet challenging as the students are expected to solve problems utilizing different laws of the physical world, theorems and theoretical data. The five methods to be used are calorimetry, bond enthalpy, Hess's Law, using heats of formation and the mathematical expressions of Hess's Law, and Born-Haber cycles. Students should be able to identify problems and needs and adjust their process accordingly.

LG3 also encourages students to take pride in their abilities and curiosity. The standards getting into the nature of scientific knowledge, as well as habits of mind of a scientist, are approached in this learning goal.

Learning Goal 4: Students will be able to appropriately draw energy cycles.

Alignment with standards:
National Science Education Standards
Content Standard A: Science as Inquiry, grades 9-12
Recognize and analyze alternative explanations and models

- Students will be examining a logical series of reactions so as to decide if the alternative process is equal.

Content Standard B: Physical Science, grades 9-12
Conservation of Energy and the Increase in Disorder

- The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, however it can never be destroyed.

Benchmarks of Science Literacy (from Project 2061)
4E: The Physical Setting: Energy Transformations, grades 9-12

Whenever the amount of energy in one place or form diminishes, the amount in other places or forms increase by the same amount

12B: Habits of Mind: Computation and Estimation, grades 9-12
Make up and write out simple algorithms for solving problems that take several steps.

Levels of Bloom's Taxonomy:
Comprehension: Students will **classify** types of reactions and **describe** the appropriate energy cycle

Application: Students will **illustrate** and **sketch** their thought process in a visual aid.

Synthesis: Students will **organize** a series of reactions and steps into one cycle.

Appropriateness:

Learning cycles are something that is introduced to the students by the International Baccalaureate (IB) curriculum. The cycles help to illustrate how energy is conserved and to illuminate the alternate pathway being taken. I think that this LG will help students to develop a visual aid if they are having trouble unifying individual or linear reactions (Hess's Law, Born-Haber cycles). Students are familiar with the concept of a cycle from earlier science courses, and can compare their "energy cycle" to other cycles like water, rock, or carbon cycles in earth science. The difficulty here I think for some students will be in determining which way arrows would go in alternate reactions, and also in determining which compounds are intermediate products.

3. Assessment Plan

Learning Goal #1: *Students will be able to design and carry out calorimetry experiments*

Learning Goals	Assessments	Format of Assessment	Adaptation
Learning Goal #1: Students will be able to design and carry out calorimetry experiments	Pre-Assessment	Observations of student performance in the laboratory	Repeat and modify instructions, as needed. Demonstrate and give suggestions to students who seem to be unsure.
	Formative Assessment	Quizzes and homework	Students will receive partial marks for attempts on homework and can come to see me for guidance.
	Post Assessment	Lab report (rubric scores) The rubric scoring is based on the IB criteria for design, data collection and data processing.	I will accept a rough draft, which I will make notes on and hand back

After an introduction to what calorimetry is, how it is performed, and a simple setup drawn on the board, students will be told to explore calorimetry. They will be given various chemicals and must determine which would perform an exothermic reaction and setup a proper calorimetry apparatus to do so. The pre-assessment for LG1 is based on teacher observations of effort and level of inquiry. All students are expected to plan before starting, to complete at least two experiments of different reactions, and attempt to solve for enthalpy. Since this is the students first time doing calorimetry experiments, I do not expect them to be experts. If there are any problems or they need assistance, I will lead them in guided inquiry toward a solution. If I see students doing something that will not lead to good results, unless it is dangerous I will let them continue and then discuss with them why it may not have worked.

Students will develop the concept of calorimetry by completing progressively more complex questions from their textbook. They will be assessed on whether they correctly answered the question. Students will also get marks for attempting to answer a question or being on the right path toward the correct answer. Questions will be covered during class discussions.

LG1 will be post-assessed with a lab practical and lab report. The students, in groups of two, will design and carry out their own experiments to determine the enthalpy change of combustion of magnesium using calorimetry and Hess's Law (LG3). The lab report will be assessed on the following rubric based on an IB rubric and the criteria of design, and data collection and processing. I have decided to accept rough drafts as an adaptation because this is what my cooperating teacher does and the students are used to it. It will also give them a chance to turn in their best work. My proficiency goal for LG1 is for half of the class to get ten points out of twelve, and for 75 percent of the class to get at least five out of six points on the data collection and processing criterion.

LG1 Lab Report Rubric

	DESIGN		
	Defining the problem and selecting variables	**Controlling variables**	**Developing a method for collection of data**
2	Formulates a focused problem/research question and identifies relevant variables	Designs a method for the effective control of the variables	Develops a method that allows for the collection of sufficient relevant data
1	Formulates a problem/research question that is incomplete or identifies only some relevant variables	Designs a method that makes some attempt to control the variables	Develops a method that allows for the collection of insufficient relevant data
0	Does not identify a problem/research question and does not identify any relevant variables	Designs a method that does not control the variables	Develops a method that does not allow for any relevant data to be collected
DATA COLLECTION AND PROCESSING			
	Recording raw data	**Processing raw data**	**Presenting raw data**
2	Records appropriate quantitative raw data, including units and uncertainties where relevant	Processes the raw data correctly	Presents processed data appropriately and, where relevant, includes errors and uncertainties
1	Records appropriate quantitative raw data, but with some mistakes or omissions	Processes raw data but with some mistakes and/or omissions	Presents processed data appropriately, but with some mistakes and/or omissions
0	Does not record any appropriate quantitative raw data or raw data is incomprehensible	No processing of raw data is carried out or major mistakes are made in processing	Presents processed data inappropriately or incomprehensibly

Learning Goal #2: *Students will be able to define the standard enthalpy change of formation and apply it to solving problems*

Learning Goals	Assessments	Format of Assessment	Adaptation
Learning Goal #2: Students will be able to define the standard enthalpy change of formation and apply it to solving problems	Pre-Assessment	Self-assessment	Students will write their response in their notebooks
	Formative Assessment	Observations of students responses during class lessons	Informally assess understanding
	Post Assessment	Exam	

LG2 will be pre-assessed by a way of self-assessment. The students will be asked, based on what they know or think, to write the definition in their notes. This is similar to the K portion of a KWL chart. While this is happening, I will be walking around the classroom to **assess** and looking at each student's paper to see what they have written. Because all students are not native English speakers and one student has a stutter when speaking in front of the class, I have made the **adaptation** to have the students write their responses.

During class lessons, when the standard enthalpy change of formation comes up, I will ask the class for the definition or for other information regarding the term, allow proper wait time and ask for students to raise their hands. I will call on a student that does not have his or her hand raised. During waiting time, I will informally assess students understanding by eye contact, body language, and facial expressions.

On the final exam, students will be asked directly to define the term, and will necessarily need to understand it to solve other questions. My proficiency goal for LG2 is for 75 percent of the students to correctly define the standard enthalpy change of formation and to directly use it correctly on a question on the final exam.

<u>Learning Goal #3:</u> *Students will determine the enthalpy change of reactions using five different methods*

Learning Goals	Assessments	Format of Assessment	Adaptation
Learning Goal #3: Students will determine the enthalpy change of reactions using five different methods	Pre-Assessment	Homework – 5 questions	Bookkeeping notes for each question
	Formative Assessment	Student work during class and homework set	
	Post Assessment	Exam questions	Partial credit will be awarded and errors allowed to carry over

LG3 is probably the most important learning goal because the outcome of the other learning goals leads to success of LG3. With this being the case, much of this lesson will be around assessing this learning goal. Students will be pre-assessed by completing a simple 5-question worksheet at the beginning of the unit. My proficiency goal is for 75 percent of the students to get at least two questions correct. Students processing skills will be assessed and will determine the course of instruction thereafter. Formative assessment will arise when each new method of solving enthalpy changes is introduced (calorimetry, bond enthalpies, Hess's Law, mathematical statement of Hess's Law using heats of formation, and Born-Haber cycles). After doing examples together, students will be given one or two more questions to answer on their own. Also, a homework set will be given to further practice solving with different methods based on the given information and the desired result.

The post assessment will be based on the exam at the end of the unit. There will be one question for each of the five methods mentioned above. Partial credit will be given because there are multiple steps involved in these types of questions. My proficiency goal for this assessment is for 75 percent of the students to successfully answer one question with each method.

<u>Learning Goal #4:</u> *Students will be able to appropriately draw energy cycles*

Learning Goals	Assessments	Format of Assessment	Adaptation
Learning Goal #4: Students will be able to appropriately draw energy cycles	Formative Assessment	Informal assessment of student work in class	Students who are struggling will be given cycles already started or partially filled in
	Post Assessment	Exam prompt to draw one Hess's Law energy cycle and one Born-Haber cycle	Partial credit will be awarded and errors allowed to carry over

Students will not be pre-assessed on LG4. Formative assessment will be carried out informally during class based on work and interaction during lessons. I have made the adaptation to give students partially filled in cycles until they become more proficient because some students may need assistance in getting started.

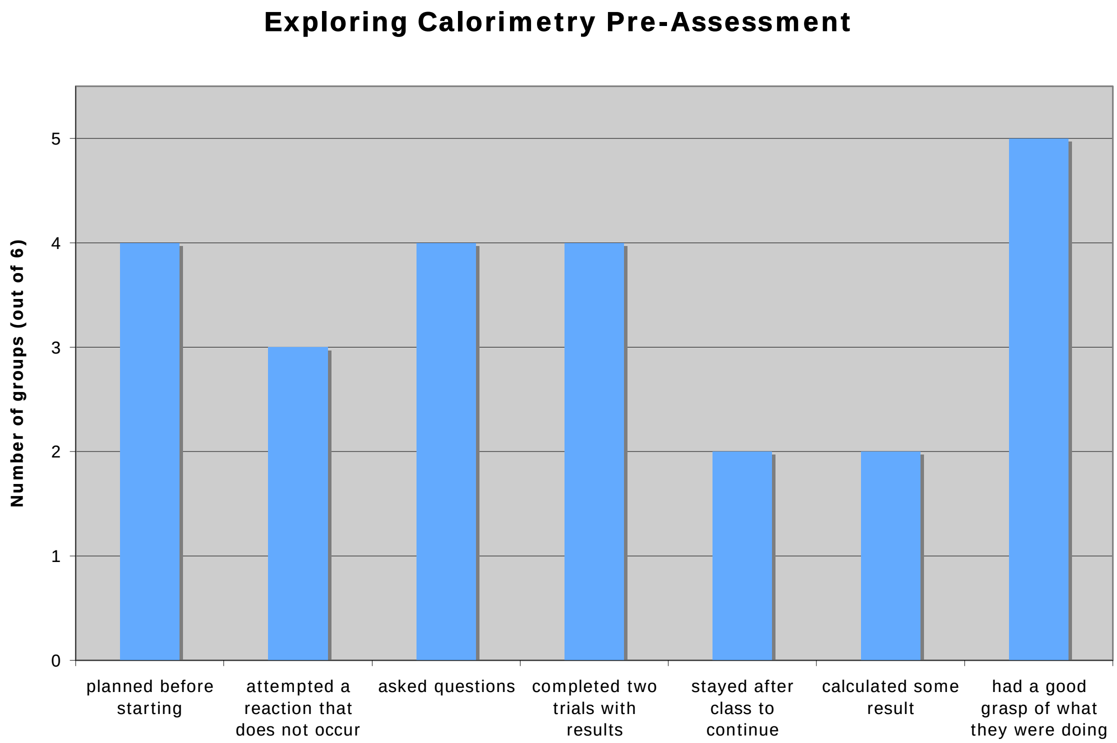
On the exam at the end of the unit, students will be assessed on their understanding of energy cycles and LG4 with one question each on Hess's Law and Born-Haber cycles. Each question will be four points; two for correctly identifying the reaction and two points for correctly drawing the cycle. Partial credit will be awarded because drawing cycles involves many steps. My proficiency goal for LG4 is for 75 percent of the class to get 6/8 (75 percent) of the points on these two questions.

4. Design for Instruction

Pre-assessment Information

LG1.

Table 1 (LG1)



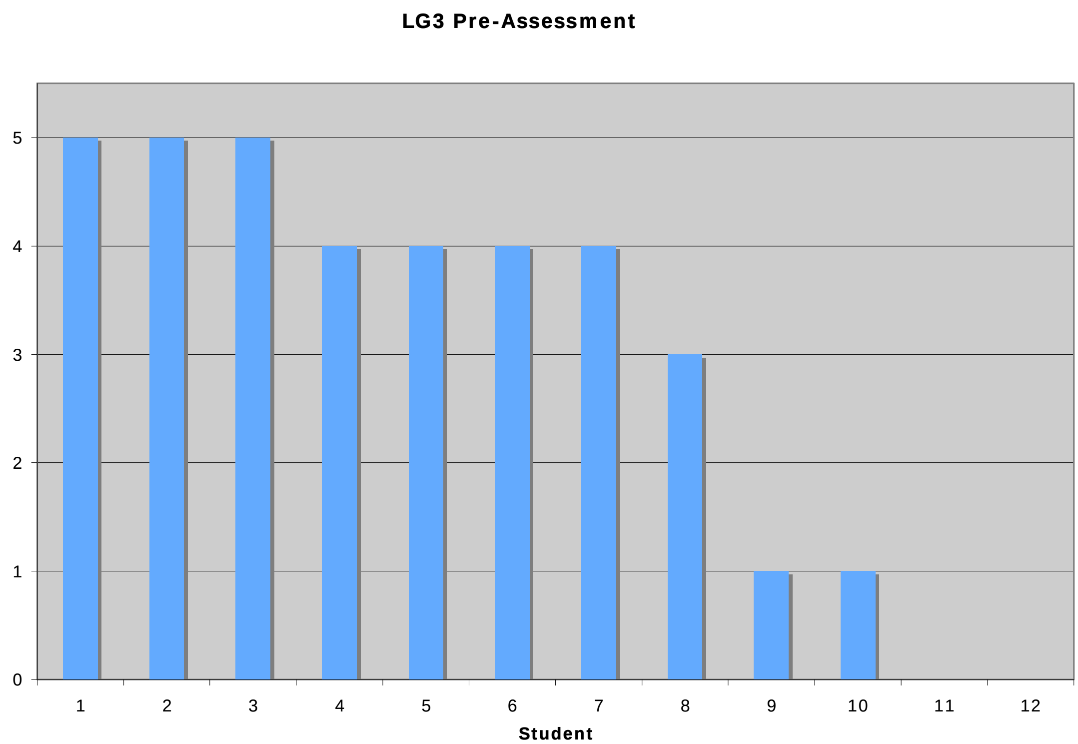
Qualitative pre-assessment for LG1 was based on observations and interactions with the students while they were working. Based on this data, most of the class (5 out of 6 groups) had a good grasp of what they were doing in experimentation, but also over half of the class (4 out of 6) had many questions (about the setup). Less than half of the groups (2 out of 6) were able to calculate an enthalpy change. So it seems that most understand what they are doing, but are not able to take it a step further to solve for enthalpy at this time. Knowing this, I see they need assistance with what values to use in the equation for heat transfer, $q=mc\Delta T$. An **adaptation** that I have made based on this data is to include a bookkeeping technique to help them keep track of what values to use (LG3). Students' questions here led to Activity 2.

LG2.

LG2 has been pre-assessed by a self-assessment from the students and my observations. I was looking for an answer with two main points: formation from elements, and those elements are in their standard states. Results are that 11 out of 12 students said that it is a formation of a compound from its elements, and 8 out of 12 students reported that those elements must be in their standard states. From these results, it will be important to emphasize that we are using standard states, and to point out the symbol used to denote this. Examples of formation reactions should be beneficial.

LG3.

Table 2 (LG3)



The results of the homework set (Table 2) indicate that most students are performing well, but my proficiency goal was not met. Only 67 percent of the class correctly answered two questions. However, of the two students who correctly answered zero questions, one of them did not attempt any questions and one of them only attempted three. Students 9-12 will need more practice and more guidance. I feel that these students may just need the motivation to do their work. I will emphasize the importance of this skill and explain relevance to their lives from boiling water and cooking, to engines and power, to energy from food. I will give future questions that show more interesting situations of heat transfers.

Unit Overview

Monday (40 min)	Tuesday (80 min)	Thursday (60 min)	Friday (40 min)
	Reading assignment over calorimetry	**7-** Activity: Open-ended exploration of calorimetry in lab (Pre-assess LG1)	**8-** Discussion of results and concept development. Hand out first calorimetry homework worksheet (pre-assess LG3)
11- Go over worksheet and collect. Introduction to Bond Enthalpies (LG3) and class time to work	**12-** Introduction to standard enthalpy of formation (pre-assess LG2) and Hess's Law (LG3) HW: problems to work on.	**14-** Hints for solving Hess's Law problems and practice. Introduction to cycles (LG4). HW: cycle question	**15-** Demo: Use calorimetry and Hess's Law to determine the ΔH^{o}_{f} of CaO. Laboratory task: Explore the combustion of $Mg_{(s)}$. Planning
18- Activity: Mg Lab (LG1, LG3) HW: Start on a homework set (LG1, LG3, LG4)	**19-** Activity: Mg Lab (LG1, LG3)	**21-** Mathematical statement of Hess's Law (LG3), Born-Haber cycles (LG3, LG4) HW: practice problems	**22-** Collect homework set. Review questions.
25- Hand back homework. Review.	**26-** Unit exam (LG2, LG3, LG4)		

Activities:

Activity 1: Exploring Calorimetry

This activity is planned for the students to explore the concept and draw their own conclusions about heat transfer and how it can be utilized to solve for enthalpy. This **relates** to my instruction and LG1 as the students first experience with calorimetry. This activity will be the basis for my **pre-assessment** information, and it is my first time to see how the students are in the laboratory setting. Contextually, I have been told that the students are motivated in lab and this will be my opportunity to see for myself. For this activity, the **materials** that I need will be acquired from the chemical stockroom and laboratory shelves. I will present them with different solutions (acid, base, some salts) and metals. I will guide the students toward other equipment (polystyrene cups, lids, thermometers, graduated cylinders) but allow them to set up their own apparatus. Students can also use the **technology** of a temperature probe if they choose to, though they are limited. **Pre-assessment** will take place during the activity, noting how students approach the problem and how efficiently they work. After the activity, students will be informally assessed on their interpretation of results in a class discussion.

Activity 2: Applying Hess's Law and calorimetry

This activity/demonstration is **related** to instruction as it is the first time the students have explicitly seen the combination of two concepts used together to solve for an enthalpy change. To determine the enthalpy change of formation of calcium oxide, which is very difficult to determine directly experimentally, alternative reactions can be performed with calorimetry and Hess's Law applied to solve for the target equation. I will write Ca + acid and CaO + acid reactions on the board and ask the students to look up the heat of formation of water and to solve for the target equation using Hess's Law. Once this is done, the calorimetry experiments will be performed using the reactions stated, determining the enthalpy changes of reaction to input into our thermochemical equations. This activity **stems from pre-assessment** information that students had some difficulty with calorimetry and would like some demonstration of it (LG1). It also is performed as a demonstration rather than a whole class activity due to limited stock of quality acid, as discussed in **contextual factors**. Students learning and understanding will be **assessed** by their application toward and efficiency of planning for Activity 3.

Activity 3: Exploring the combustion of Magnesium (Lab)

This will be a multi-day activity. Following the demonstration and discussion of finding the heat of formation of calcium oxide, students should see the connection between that reaction and the combustion of calcium (the reverse reaction), and apply this forward to solving for the combustion of magnesium (same group as calcium) in a similar fashion. Because of this, there will be no instruction for planning or design given. Students will be operating in student-centered inquiry. Students will determine on their own what **materials** and **chemicals** they will need to implement this activity. It should be something like magnesium metal, magnesium oxide solid, and hydrochloric acid, along with the equipment described for Activity 1. Students' lab reports will be **assessed** with the required IB rubric. I have chosen to assess two criteria, Design, and Data Collection and Processing. These two were chosen because they relate directly to how well students accomplish LG1 and LG3.

Technology:

Technology will be used sparingly during this unit. The **rationale** for this decision is that implementation of technology will not contribute to student understanding. It is also useful to show that this unit does not require advanced technological instrumentation and yet it is still clearly useful science. During calorimetry experiments, temperature probes could be used, but there are not enough for all groups, so they will only be offered if asked for. Students will time their experiments (to make a chart of temperature vs. time) and can use a stopwatch, though the clock in the room with a second hand would do just as well.

Contextual Factors:

When designing my lessons plans, I am focused on the many implications of my contextual factors. First, due to the physical setting of the classroom, the uncomfortable chairs and close quarters to lab equipment, when lecturing and going through examples, I will give opportunities for different students to complete a problem on the board. This will give them the chance to stand up and move around and to maintain some activity. When performing labs, I will be asking the students to be creative in their design and to microscale if needed, due to some limited supplies.

Taking notice that the students come from different backgrounds and from all over the world, I will need to make sure that I give sufficient background (unless I want them to inquire and maybe reach some disequilibrium before figuring it out for themselves) and introduce all new terms. If I see that they are actually all on a 'similar page', I will reduce my instruction. As the class has both boarding students and day students, I will not assign out of class work that requires anything more than a textbook and notes. Though most students come from wealthy families, as mentioned, I do not know if they all have Internet access. Even if they did, Internet in Africa is very unreliable.

Focusing on students' skills and interests, I will design chances for the class to perform activities and to facilitate classroom discussions.

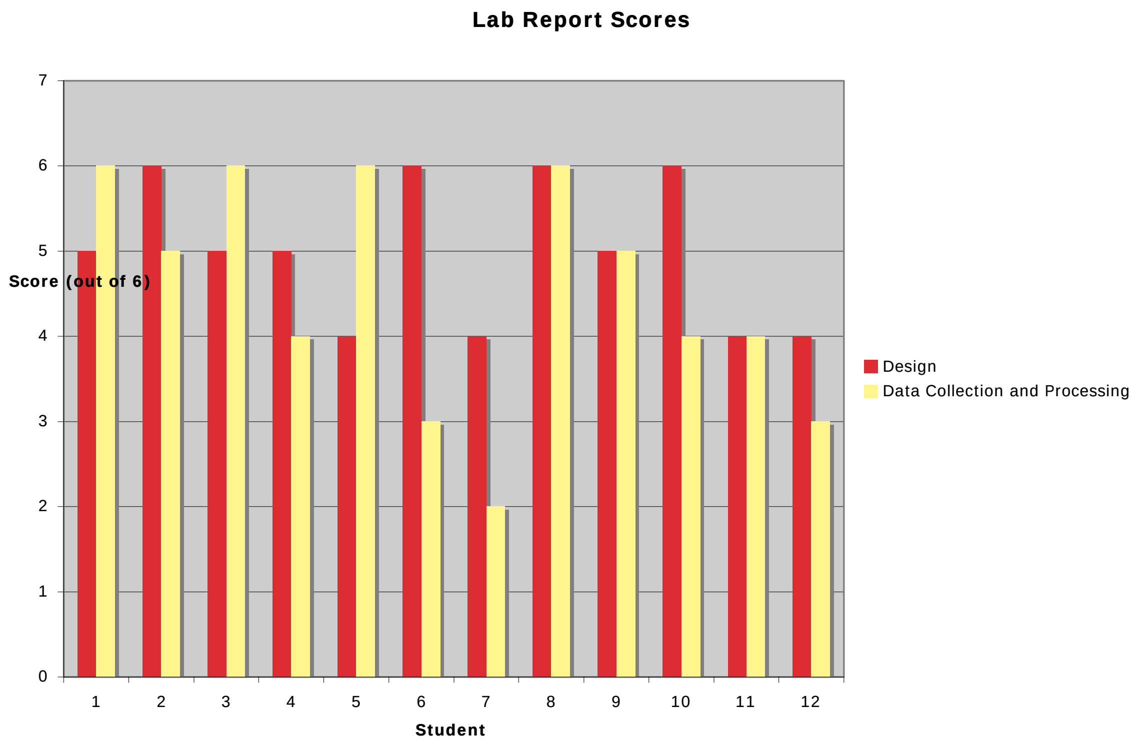
5. Instructional Decision-Making

A time when my formal assessment of the class changed my instruction was during my lesson on the standard enthalpy change of formation. I thought that I was wrapping things up when Student X (described in Contextual Factors) raised his hand and asked what would be different if we used iodine gas rather than standard iodine solid as a reactant. I assessed that he did not understand what was meant by "standard state" by his question. He is one of the top students in the class, and if he had some difficulty in this, I thought that others might as well. Also, I knew from my Contextual Factors that some students have different backgrounds. I decided to address his question by modifying my method of instruction and my lesson for the day. To help the students understand the idea of a "standard state" I referred them to the colored periodic table on the wall and we determined how to read the physical state of different elements from the table. I also asked them to reflect on their own experiences with different elements: metals, oxygen, nitrogen, etc. I also reviewed with them which elements are diatomic in their standard states. From here, I posed Student X's question back to the class. We discussed the difference in the particle arrangement and the energy of solids, liquids and gases. I asked Student X now to tell me what would happen if an element were used in the reaction not in its standard state. He correctly answered that we would have to account for the enthalpy change of formation of that element from its own standard state, and add that to the overall enthalpy change. I believe that this modification was in congruence with LG2.

Another instructional decision I made was when a student was struggling to understand Hess's Law; that the enthalpy change will always be the same independent of the pathway taken as long as the starting and ending products do not change. He raised his hand during class work time near the end of the lesson. While other students were working on problems that I had given them, I was able to help the student. I thought that a visual aid would be helpful, and on the board together we drew an energy diagram for the vaporization of water (from liquid to gaseous water). I showed him where the products and reactants were relative to one another on the diagram based on heat of formations, and how we were raising or lowering the energy with our pathway. No matter what we did the overall enthalpy change would be constant. He nodded along with me, and was happy to see the problem another way. After this, I realized that the energy diagrams would be beneficial to the entire class, and at the start of the next lesson I showed it to everyone. I asked the student from the day before for input, and he was able to answer and help the rest of the class understand the diagrams.

6. Analysis of Student Learning

Table 3 (LG1)



LG1 was that students would be able to *design and carry out calorimetry experiments*. This goal was assessed with a grading rubric as given in the Assessment Plan. My proficiency goal for his learning goal was met with 7 out of 12 students getting ten or more points. However, only half of the class received five or better on data collection and processing, unfortunately not meeting the second part of the proficiency goal. Overall, based on formative assessment and post-assessment of the lab report, this learning goal was not proficiently met. Possible reasons for this lack of success are discussed in the Reflection section (page 33).

Table 4 (LG2)

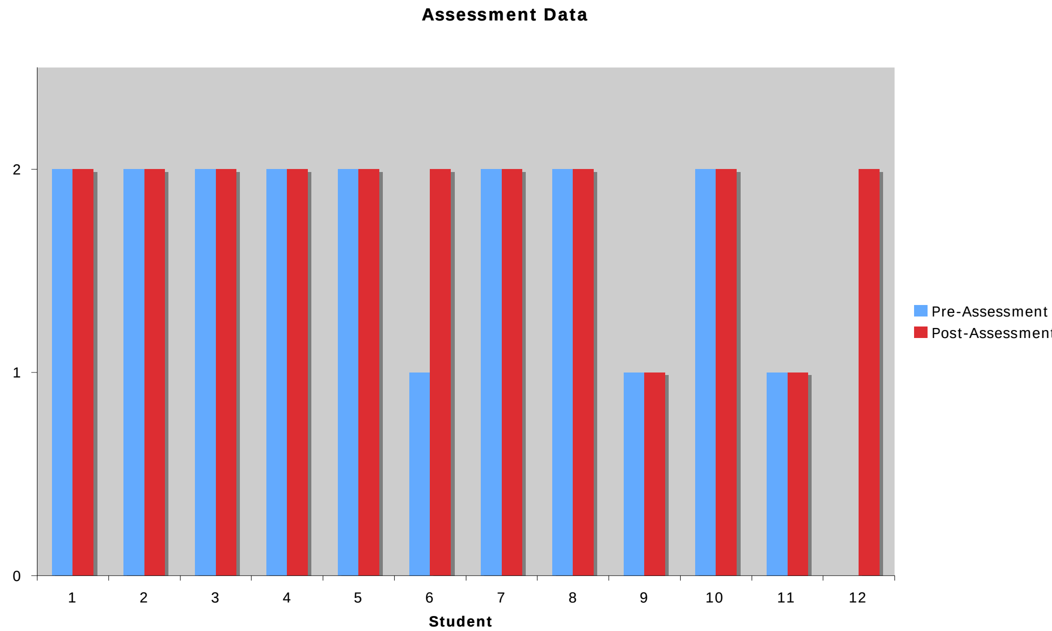
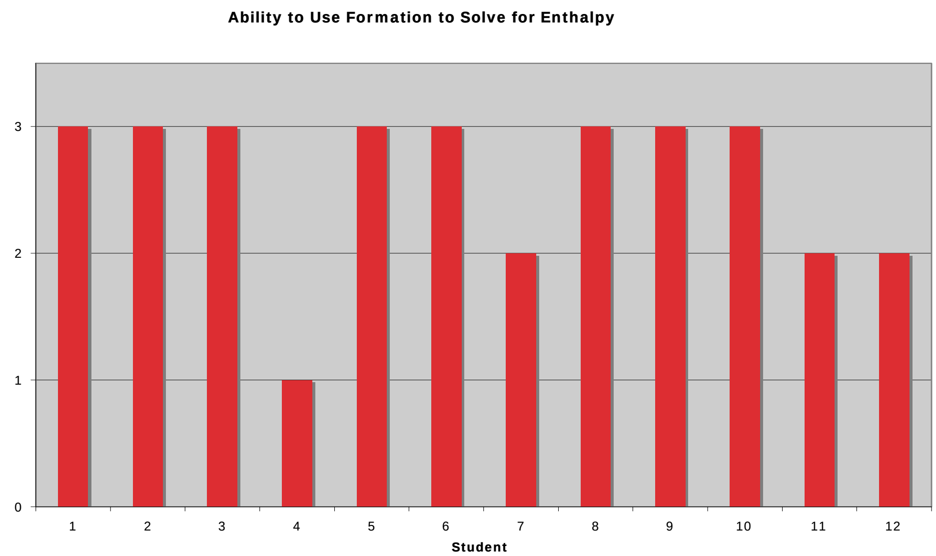


Table 5 (LG2)



LG2 was that students would *be able to define the standard enthalpy change of formation and apply it to solving problems*. Table 4 shows pre and post assessment data for definitions given, with one point being awarded for each component of the definition given. Of the four students who did not receive full marks on the pre-assessment, one half of them improved to full marks on the post-assessment. Table 5 shows the students' ability to use their understanding of the standard enthalpy change of formation to solve a problem. A total possible score of three points was given for correct setup, answer, and determination of exothermic or endothermic from the answer.

My proficiency goal for LG2 was for 75 percent of the students to correctly define the standard enthalpy change of formation and to directly use it correctly on a question on the final exam. Tables 4 and 5 show that 6 students, or 50 percent of the students, received full marks on their definition and ability to solve a problem. 75 percent of the students were able to fully define the term but use it only partially correctly. Though my proficiency goal was not met, I believe that overall this learning goal was successful based on Table 4 and my formative assessment during class. Also, application of the definition, shown in Table 5, was successful, with the majority of mistakes being minor mistakes.

Table 6 (LG3)

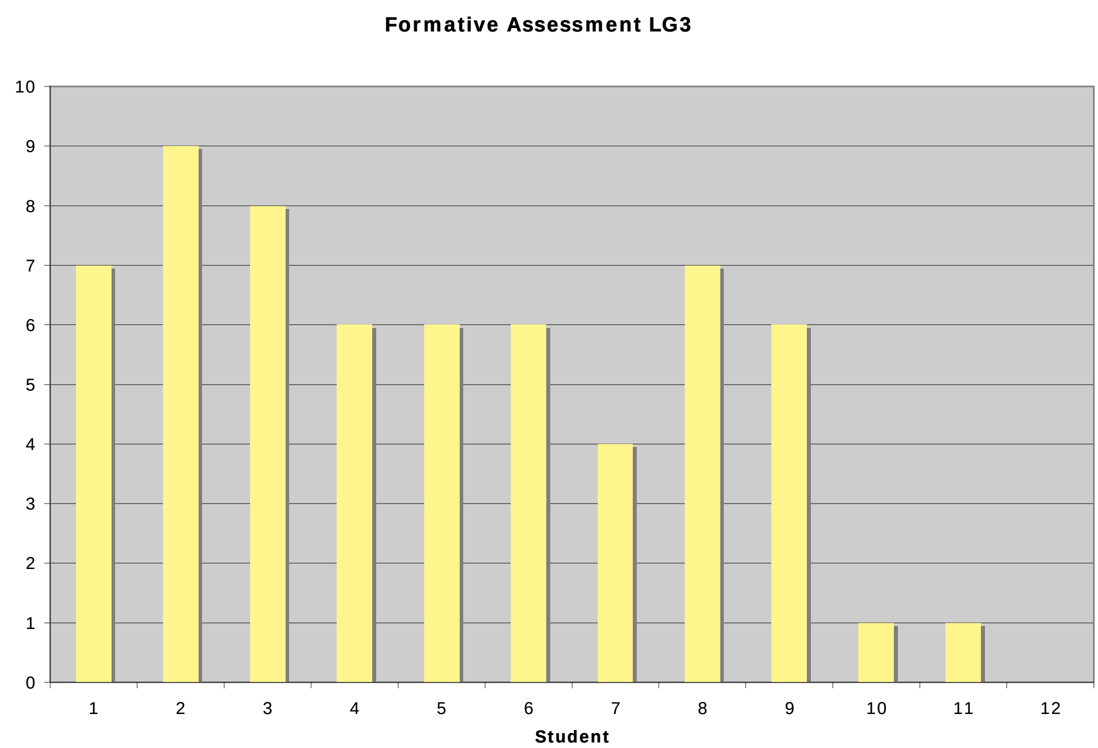


Table 7 (LG3)

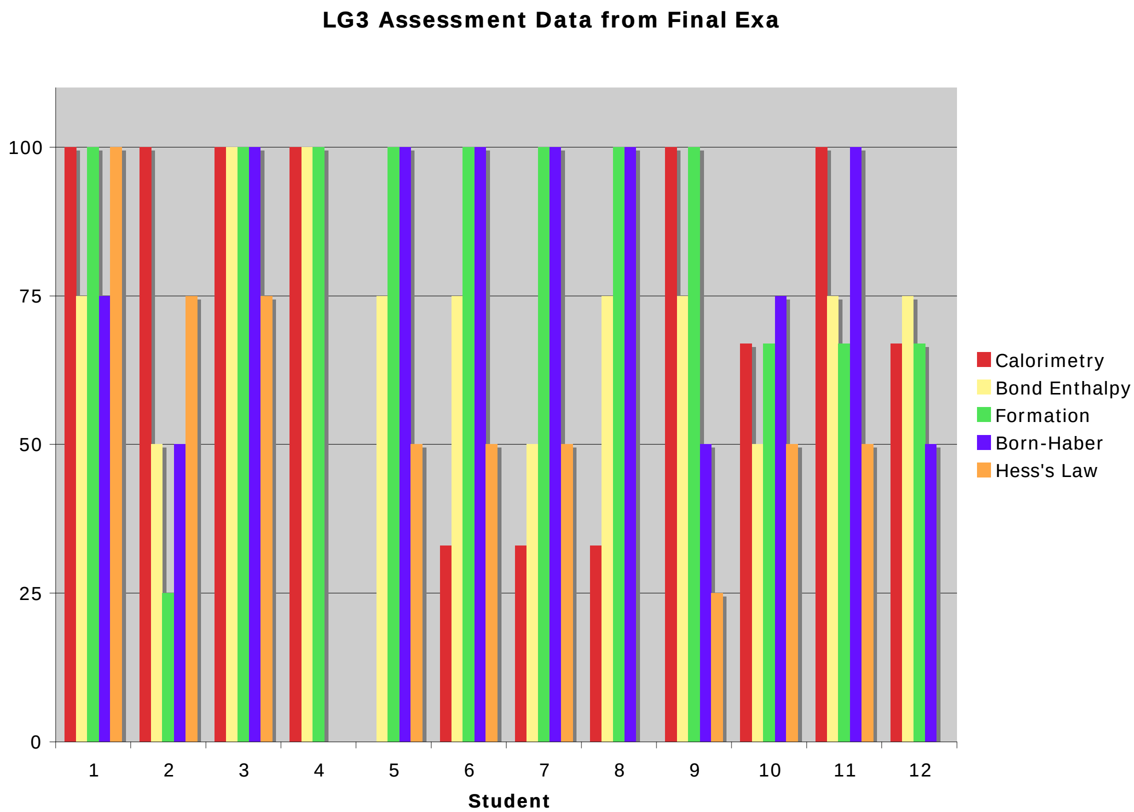


Table 8 (LG3)

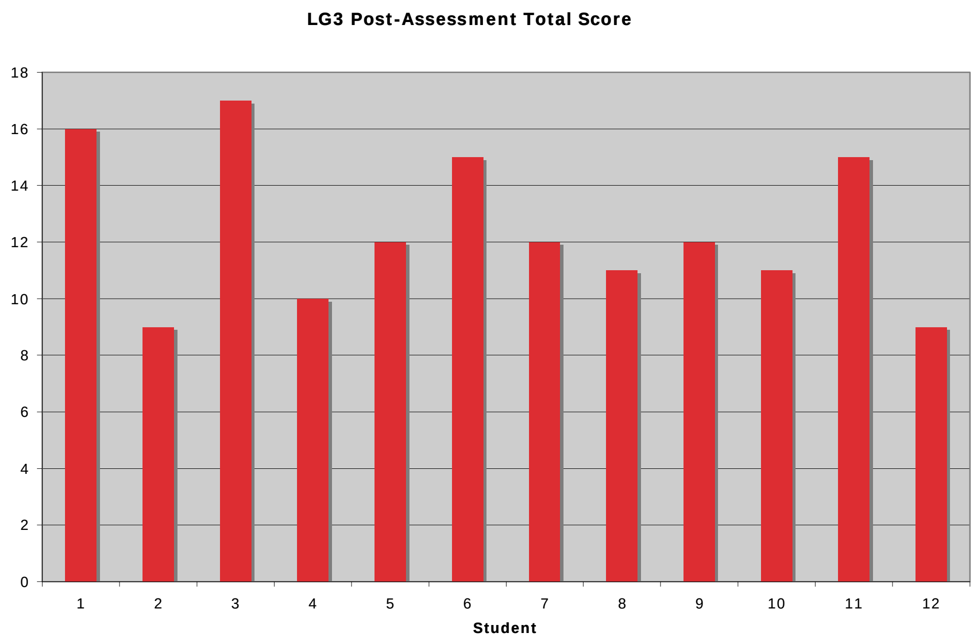
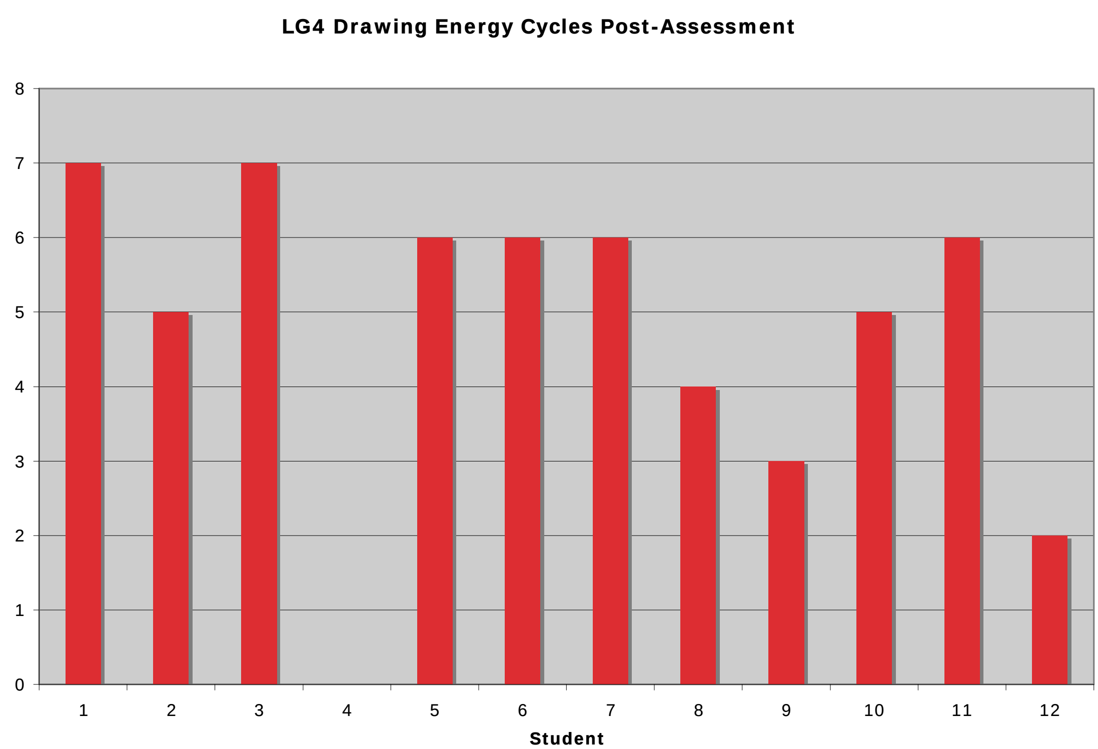


Table 6 shows formative assessment, based on homework collected during the unit. There were nine questions possible. Students 10, 11, and 12 did not finish the homework to completion, and left many of these problems blank.

Tables 7 and 8 show post-assessment data for LG3. There were five questions with one relating to each of the methods mentioned for solving enthalpy problems. Table 7 shows each student's score on each of the five questions. My proficiency goal was for 75 percent of the students (9 students) to correctly answer all five. This was not met, and actually no student answered all five correctly. I seemed to have high expectations. Hess's Law seemed to cause the most problems, and enthalpy of formation was most successful. The other three methods were all correctly answered by half of the class. Table 8 shows their combined score for those five questions. Every student was above 50 percent, showing that students were able to answer questions partially correct.

Table 9 (LG4)



My proficiency goal for LG4 was for 75 percent of the students to get at least six points. The total of eight points also includes the ability to solve a problem using the cycle. Table 9 shows that one half of the class met the goal. The two questions were placed at the end of the test, and some students did not get there with sufficient time left (Student 4, for example). 75 percent of the students did receive at least four points, which reflects that they were able to receive partial credit on both drawings of cycles. Most points lost were due to incorrect stoichiometric values within reactions, with the general understanding and flow of the cycle remaining in tact.

Individuals:

In regards to LG1, Student Y (Student #11) scored 4 out of 6 on both criteria, which was a good improvement for him because he was in the group of students who did not do well in the pre-assessment. He started without planning, and ended up meeting many difficulties. I was pleased to see him show up for the final lab with preparations and a design planned. Though there was improvement, he still did not meet the proficiency goal I had set out. There was improvement in his data processing skills, though he is still inconsistent. His formative assessment was very weak, and this is due to the fact that he did not even attempt all of the problems. This contributes to the comments made in Contextual Factors about his attitude toward chemistry. In regards to LG2, Student Y did not show any improvement or correction from his initial mistakes. Also, he was not able to proficiently apply given standard heats of formation to solve for the enthalpy change of a simple reaction. In regards to LG3, Student Y performed poorly on the formative (homework) but was near the top on post-assessment, meeting the proficiency goal. To me, this seems like an effort issue. It is promising to see him perform well on the exam on this prominent learning goal, but due to his inconsistencies it is difficult to determine his achievement level. It is important to understand his learning and performance because there are many students like him, students that do not particularly care about chemistry, and it is important to make their experience meaningful and positive.

In regards to LG1, Student Z (Student #8) performed the best in the class with her lab report. Comparing that to LG3, where Student Z had the overall worst grade in the class on the test, the Contextual Factor comments that she gets nervous on tests are reaffirmed. When she had the time to sit down and work her way through a problem, as in her lab report, she excelled. In regards to LG2, Student Z met all of the proficiency goals. She correctly understood the definition was able to apply it correctly. In regards to LG4, Student Z did not meet the proficiency goal. She received full marks on Born-Haber cycles, yet received no marks on Hess's Law cycles. Her mark on the exam is disappointing when compared to her formative and individual learning goal assessments. Her learning is important to understand because I believe that test scores alone do not show her learning, but rather it is a combination of all formative and summative assessments. She also shows the importance of different methods of assessment.

7. Reflection and Self-Evaluation

The learning goal that was most successfully met by the students was LG2, defining the standard heat of formation and applying it along with Hess's Law to solve for the enthalpy change of reactions. The mathematical statement of Hess's Law, making use of the heats of formations, is considered a shortcut way to solve a problem. The important thing to remember when using it is why it works. This is why understanding both Hess's Law and the standard heat of formation is important. On the post-assessment, 10 of the 12 students correctly defined what the standard heat of formation is, and 11 of 12 students demonstrated understanding of a "standard state," an important concept. Two thirds of the class was able to solve for the enthalpy change of a reaction with complete proficiency, and 11 of 12 students were able to show a good understanding. One possible **reason for this success** is that the concept of the "standard state" came up a lot during instruction. The students were exposed to this idea and questioned on its meaning and relevancy frequently. Students had many chances to think about this and to practice using it. This is how every learning goal and important concept should be exposed to the students. Another **reason for success** is that I think students like it when things fit into nice equations, and the application of these values makes use of a nice equation. The equation is of a common form in chemistry, of a "products minus reactants" form, and is fairly easy to remember.

The learning goal in which the students were least successful was LG1, designing and carrying out calorimetry experiments. I was disappointed at the level of proficiency seen during lab and on the written lab reports. I tried to challenge the students by giving them an open invitation to inquiry and the opportunity to figure it out on their own. I think because of this approach however the whole lab had an atmosphere of disorganization and uncertainty from the students and this is a possible **reason** for the lack of success. The students did not show the level of motivation and maturity that I expected from them. Another possible **reason for lack of success** with this learning goal is that students still seemed unsure of calorimetry. Based on the questions I received and the first approaches of some groups, they had not had enough practice or experience with calorimetry. The first exploration of calorimetry may have hindered them rather than being a positive experience because it was very early in the unit and they did not take it seriously. When approaching this learning goal in the future to **improve students' performance** I would give them an opportunity to be in the lab with a designed activity before designing their own. Nothing can replace the experience of successfully performing a skill or activity. This would give the students the confidence and familiarity with how calorimetry is actually used and applied and then they could go on to design their own experiment. Another thing that I would do **differently** would be to give the students a more definite timetable for the activity. I did not tell them my expectations before they started and I adapted the schedule for additional days with the lab. If I told them from the beginning that I expected them to finish planning and collecting data in two class periods, for example, they would have been more focused, which could have led to better attention to the details of the lab and to more pride in the results. The **adaptation** that I made for this lab report was what my cooperating teacher does with the students. They turn in a rough draft of their lab write-up to be checked before a final is turned in for marks. This was an adaptation to me because I would not have done this on my own, at least at this point in the year. I think that it was effective because I saw a lot of mistakes on the rough drafts that were then corrected. However, I would like to see students make those corrections themselves. I am afraid that I was telling them too much, giving too many answers. It seems to not force the students to think critically and analyze their results on their own. I do not think that I will adopt this adaptation.

Another **adaptation** in my assessment plan was to model to students good ‘bookkeeping’ habits. I added this to my lesson after many of them did not know which values were supposed to be used in which equations. I saw many students use these habits on their exams and their lab reports data processing. This will become a normal part of my lesson form now on.

Professional Development Goals:

One area of professional development that I have become aware of from this experience is in establishing a routine and my expectations for my classroom. There was an added difficulty for me coming into this classroom midway through the school year. My cooperating teacher already had his routine and his expectations in place. I am a different teacher and it was difficult at times to maintain my independence and authority as a teacher when the students expected something else. This was, however, a good model for me during my observations to see how a classroom runs when teacher and students are on the same page. The first days of school are very important in establishing your routine and letting the students know what your expectations are. Also, I have learned that it is important in establishing a routine to be consistent with it. One **step** that I will take to improve in this area is to spend the rest of the semester and this summer thinking about and planning how I want my classroom to be run. I have observed three different teachers at this school, **and I will** continue to observe them and discuss classroom expectations with them. I know that this is a part of my career that I can continue to make adaptations to and to grow in as I become a more experienced teacher.

Another professional development learning goal that I have is to become familiar with a vast curriculum. My cooperating teacher has been teaching for 14 years and has binders and binders full of lessons and lab activities. One **step** that I will take to achieve this goal is to attend more curriculum workshops. I took the curriculum available to me while at UNI for granted during my field experiences. I want to attend different workshops and receive curriculum and inquiry activity ideas. I think that it is important for teachers to attend workshops every year to stay up-to-date and in community with other teachers in the same subject.

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