ENACTING A REFORM-BASED SCIENCE CURRICULUM: DESIGN CHANGES TO EXTEND INQUIRY

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The first author re-entered the middle grades classroom to teach a new National Science Foundation (NSF) physical science curriculum that was designed to foster conceptual change through a scientific approach. The curriculum design met the need and call for reform in science education through its focus on inquiry, evidence-based reasoning, peer collaboration, and deeper understanding of important concepts in a science discipline. Lessons followed a learning cycle of activities for knowledge construction. As a self-study, the first author as teacher sought to learn about his beliefs and abilities in practice while enacting and adjusting the curriculum design. The second author helped in this reflective practice through visiting the first author's classroom for periodic observations, interviews, and discussions about the implementation of this curriculum. Four videotaped lessons and instructional artifacts demonstrate that the teacher enacted the curriculum with high fidelity to its prescribed inquiries and learning cycle format with only minor changes. Instructional design modifications were made in practice to assist lower achieving students meet its high academic challenge of analytical thinking. The merits of the prescribed curriculum for promoting deductive scientific thinking are detailed alongside instructional design decisions emanating from the curriculum's academic rigor and limitations in connecting to adolescent interest and choice. This case details one example of a teacher who intended to faithfully implement

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INTRODUCTION

Inquiry in Science Education

In the field of K-12 science education today, reforms and standards continue to rely on the use of scientific inquiry as an authentic approach to learn both the content and processes of science (Next Generation Science Standards [NGSS], 2013). Recently, notions of inquiry-based teaching have been reframed as the use of *scientific and engineering practices to foster STEM literacy* (National Research Council [NRC], 2012). *In science classrooms, students use these practices to develop conceptual understanding of science and the scientific endeavor through:*

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information (NRC, 2012, p. 42).

Through inquiry, students seek answers to questions by carrying out investigations of natural phenomena. They record observations as data for later analysis. Mathematical thinking is applied to identify patterns and interpret trends relative to the scientific question under study. Evidence-based reasoning plays a central role in the construction of scientifically sound explanations. This process of sense-making is

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supported by prior learning, background information, and peer discussion, all facilitated by a knowledgeable teacher.

Structured and guided inquiry are the most common types of scientific inquiry carried out in K-12 science classrooms. In structured inquiry, the teacher or curriculum provides the scientific question and procedures by which the students seeking answers. Bridging the inquiry continuum between “structured” and “open” inquiry is guided-inquiry, whereby students investigate a question posed by the teacher, then develop procedures for conducting scientific inquiry. With limited time and prescribed courses of study, teachers rely heavily on structured and guided inquiry to efficiently teach targeted science standards. Much more rare is *open inquiry*, where students generate their own questions and procedures in investigations that can further extend student learning on topics under study (Martin-Hansen, 2002). The Interactions curriculum followed a structured inquiry format, with each activity building on the previous ones in a constructivist progression of learning aimed at developing a deeper understanding of science concepts and their relationships.

The Learning Cycle Framework

An instructional framework called the *Learning Cycle* sequences inquiry-based activities within a comprehensive plan of instruction in support of scientific understanding (Lawson, Abraham, & Renner, 1989). The *5E Model* is the most common version of the Learning Cycle used today, named for its five component phases: Engage, Explore, Explain, Elaborate, and Evaluate (Bybee, 1997). Within this framework students first **engage** prior knowledge on a topic of study in an introductory lesson before they **explore** it further through one or more related scientific inquiries. Teachers help students make sense of the results or evidence of their inquiries in light of existing scientific knowledge and ideas in the **explain** stage, adding academic vocabulary of the concept under study. Next, students **elaborate** on their understanding through its application to new situations with practical implications. These elaborations can include further study into how the science may be applied to relevant problems or social issues. During this phase of the Learning Cycle, students often become agents of creative thought through applying their new learning to relevant projects and presentations. Teachers **evaluate** student learning throughout this framework through the products of learning as well as more traditional forms of assessment. Thus, the 5E Learning Cycle includes distinct phases for optimal sequencing of activities in the instructional design.

Research supports the Learning Cycle as a constructivist framework that helps students develop deeper conceptual understanding and factual knowledge of science (NRC, 2005). Recent reform-based curriculum design in science education incorporates the Learning Cycle into a format of

spiraling lessons, units, or modules where inquiry plays a critical role in science learning.

CURRICULUM DESIGN

Inquiry within a Learning Cycle

Interactions in Physical Science® is a middle grades curriculum developed with the support of the NSF that incorporates structured inquiry-based activities designed to develop students’ accurate conceptual understanding in physical science (Goldberg, Bendall, Heller, & Poel, 2006). Through a learning cycle framework, each set of activities (called a *Cycle*) begins by first eliciting students’ prior knowledge of the concept to be studied—called *Our first ideas*. Lessons then develop scientific ideas through a series of inquiries—called *Developing our ideas*—followed by connections to scientists’ thinking—called *Putting it all together*. These inquiry activities make up the majority of lessons in the learning cycles of *Interactions in Physical Science*®. Afterwards, students apply the ideas learned through analyses and explanations of real-life scenarios that require application of the newly developed understanding—called *Idea power*. Further written explanation is given about scientific ideas that cannot be studied directly through inquiry in the classroom—called *Making sense of scientists’ ideas*. Optional activities at the end of each cycle, when present, direct students toward further study about related phenomenon in nature through additional reading and paper-and-pencil activities—called *Learning about other ideas*. These optional activities are similar to the “extensions” found in more traditional curricula. Five to ten activities make up a typical learning cycle sequence before optional activities.

The curriculum is organized by topics of study into a sequence of units-cycles-activities. See Appendix A for the table of contents for the curriculum.

Units of instruction on a physical science area of study (e.g., conservation) are made up of cycles of related subtopics (e.g., mass conservation, energy conservation). Each cycle is composed of activities that follow the previously described learning cycle format. Each activity makes a stand-alone lesson. The first unit, called *Building a Foundation*, helps lay the foundation for working like scientists and using scientific practices within collaborative teams. Further details on the description of the content in each unit can be found at the publisher’s website: <http://www.iat.com/courses/middle-school-science/interactions-in-physical-science/?type=content>

Inquiry Supporting Conceptual Change

From a sequence of inquiry activities—in *Developing our ideas*—students gather evidence as data from which they make claims about the targeted science concept. Before conducting each activity, students are challenged through

key questions to explicitly share thinking and reasoning on the potential outcomes of activities—called *I think/We think*. Students work in collaborative teams as a “community of scientists” as they carry out prescribed inquiries and record observations and data—called *Explore your ideas*. They compare prior thinking with new thinking based upon the evidence emerging from their inquiries—called *Make sense of your ideas*. The teacher and students then review outcomes together to negotiate understandings from each activity—called *Our consensus ideas*. The goal of this inquiry process is to use evidence-based reasoning to foster conceptual change in students through dissatisfaction with their initial ideas in order to readily accept the more scientific ones (Beeth & Hewson, 1999). Fostering conceptual change through this cycle of structured inquiries is the heart of the *Interactions in Physical Science*® curriculum.

Ancillary materials to the textbook that further support student learning include extensive teacher notes for reviewing the science content and carrying out the activities, a student activity book, practice sheets, cycle tests, and a supplementary student reader. These materials come in supplementary binders. Practice sheets provide students with follow-up practice problems and scenarios after each activity. Traditional tests are provided for the end of each cycle of activities.

ORIGIN OF THE DESIGN CASE

The design case presented here emerged from a traditional case study of the first author’s enactment of the *Interactions in Physical Science*® curriculum in an eighth-grade classroom (Dias, Eick, & Brantley-Dias, 2011), and is written as an ancillary product intended to communicate details about the design adaptations emerging during enactment of a prescribed curriculum. The teacher (first author), as a university professor in science education, re-entered the classroom full-time to conduct a self-study of his beliefs in practice while evaluating this new reform-based curriculum (Loughran, 2007). His colleague (second author) supported this self-study through seven visits to the classroom where he observed, recorded field notes, and interviewed the teacher on his teaching practice and instructional design decisions. Four of these observations included videotaping during one class period. Artifacts from teaching (lesson plans and assignments) served analysis of instructional planning and implementation decisions. In-depth interviews held before and after the teaching semester, provided insight on evolving teacher beliefs on practice and the nature of this reform-based curriculum design. Weekly journal reflections added further insight into the rationale for design changes and the teacher’s new practical-knowledge developed while working with students and teaching the *Interactions* curriculum.

CONTEXT OF THE CLASSROOM

The public school where this study took place is located in a rural university town in the southeastern United States. The student population made up of eighth and ninth graders was diverse: 52% European American, 37% African American, 11% other. Classes were arranged on a block system of four 96-minute periods per day (excluding lunch time) over an 18-week semester. Students studied science for one semester. Of the three classes taught by the teacher in this study, the population in each class averaged 22 students. However, the diversity of students in each class varied greatly (from 29–72% African American). According to students’ standardized test scores, prior student achievement in science before this course varied greatly.

Students sat at tables in groups of four. Texts and hands-on materials needed for the curriculum were provided. Students kept a science notebook in which they recorded their thinking, results of inquiries, and answers to given activity questions. The teacher utilized a Smart® Board and laptop computer for projecting instructions, student-generated data and responses, and class consensus answers to posed questions. Before the semester of implementation, the teacher completed a prescribed one-week training on the curriculum.

IMPLEMENTATION PLANS

The teacher (first author) re-entered the science classroom with the intent of implementing the *Interactions* curriculum as designed. The reform-based curriculum had been written, tested, and revised through a research and development process with NSF sponsorship. This physical science curriculum is unique in both its constructivist approach and emphasis on the use of inquiry as the basis for student learning. The limitation of other traditional science education curricula has been the emphasis on factual information without a strong framework for conceptual development. In addition, most traditional curricula have limited use of scientific inquiry with these reform-based activities, in some instances, supplementing the textual information, but not integrated in the text as is the case in the *Interactions* curriculum.

The teacher initially made some classroom design decisions to support the curriculum and its requisite “community of scientists” learning environment. The curriculum called for students to work in collaborative teams for most activities. From previous experience teaching middle school, the teacher knew of the effectiveness of team and individual rewards in supporting positive classroom behavior in such activities. Therefore, in consultation with the students, the teacher developed a rewards system for positive behavior support. This system outlined mutually agreed upon individual and group behaviors, and the associated rewards for maintaining them on a weekly basis. See Appendix B for the classroom rewards system co-created with students.

In addition, the teacher required the use of science notebooks where students would record all of their class activities (see Figure 1).

The science notebook would take the place of the student activity book for recording results to activities and responses to questions. There were no additional funds to purchase the student activity books, but also the teacher wanted to

implement personal science notebooks as a current best practice design for inquiry in the classroom. The rationale for notebooks was the belief that students would be more likely to take personal ownership of their learning if daily science work was recorded as a written log in a manner that is often followed by scientists. Another difference in this use of the *Interactions* curriculum involved the elimination of a learning cycle on gravity, because this topic was not part of the eighth-grade state science standards.

Due to limited classroom time to teach all of the activities in the *Interactions* curriculum, the teacher made some initial instructional design decisions. The developers incorporated teacher choice in the selection of lessons to complete at the end of each cycle—*Learning about other ideas*—and whether to incorporate the supplementary reader. The teacher chose fewer of these lessons to complete and did not incorporate the additional reader. Also, practice sheets that were intended for classwork were instead assigned as homework. Routinely, students shared their answers to the assigned homework at the beginning of the next lesson, discussing in small groups and writing responses to a subset of the assigned practice questions on white-boards for class review and comment.

DESIGN FIDELITY AND MODIFICATIONS IN PRACTICE

A Typical Classroom Lesson

In preparation for each day's lesson, the teacher followed the sequence of lessons as "activities" prescribed for each learning cycle. The manner in which the textbook laid out each activity sequence with explicit instructions reduced the typical demands on a teacher's time in lesson planning. This time was used instead for setting up instructional materials and preparing Smart Board notes as an outline to guide students in the lessons, particularly what to record in their science notebooks. See Appendix C for an example of a teacher prepared outline projected for students to follow in recording their work for each activity.

The science notebook outline followed the same activity format (i.e., headers, questions, and tables) as was given in the textbook. The outline helped students follow the lesson in the textbook, organize their notebooks, and attend to what needed to be recorded in each lesson. The teacher also provided pre-cut handouts of tables, charts, or figures that students needed to complete activities. Students taped these handouts into their notebooks in the proper place. This approach reduced the amount of time required for students to write or draw in the science journals that replaced the *Interactions* student activity book.

A typical day in this teacher's classroom began with a warm-up where the class reviewed their responses to their

FIGURE 1. Each class's individual science notebooks were kept in designated crates for use in recording observations and thinking during inquiries.

practice sheet homework problems assigned the previous day. Student teams would first record their answer to one of the practice sheet problems on their dry-erase whiteboard. The teacher assigned at least one problem per team and this assignment was projected on the Smart Board upon entering the classroom. While this occurred, the teacher went from team to team, checking that individuals completed their homework. Afterwards, the teacher facilitated table sharing of each problem and solution as seen in the video clip provided from Unit 5: Materials and their Interactions. A student representative shared the team's agreed-upon response with the class, followed by fellow students agreeing or disagreeing with their solutions. In this process students would receive immediate feedback on their work and thinking (see Video Segment 1).

VIDEO SEGMENT 1. The day's 'warm-up' on mixtures, solutions, and pure substances where student teams shared Practice Sheet responses on white-boards.

Following the homework review, the teacher introduced the next activity for the day's new lesson. Most of the activities in a cycle were exploratory in nature (i.e., *Developing our ideas*) and so the common approach of these activities epitomized a typical lesson in this teacher's classroom. The example video clip provided from Activity 3 shows an investigation involving the use of hand-held microscopes. The question that guided the inquiry was "What are three ways an object looks different through a microscope as its magnification increases?" After the introduction of the key question, students would then discuss their responses to the proposed question—called *We think*—within their teams and then as a class. This discussion scenario and question are designed to reveal students' prior thinking on the key concept under study before gathering evidence for argumentation (see Video segment 2).

The second part of the activity was the hands-on, inquiry portion of the lesson—called *Explore your ideas*. The video example provided was from Activity 8: Classifying Chemicals, and shows students observing and interpreting the electrolysis of water that they employ with provided materials. Students worked with their teammates as they followed a structured inquiry process for what to observe and record at

VIDEO SEGMENT 2. The beginning of an inquiry activity where students record the lesson's key question and their thinking about the topic.

each step of a given procedure. Along the way, they used their observations to respond to questions that further guided the inquiry and thinking through it. During this part of the lesson, the teacher roved from team to team in support of their efforts, monitoring behavior, and clarifying points of the lesson (see Video segment 3).

VIDEO SEGMENT 3. Students carrying out the inquiry into the electrolysis of water in collaborative teams while the teacher roves to assist and monitor progress.

Once students completed their investigations, they interpreted their findings through answering questions that required their use of evidence-based reasoning—called *Make sense of your ideas*. Students discussed and completed their responses with their teammates.

Afterwards, the teacher facilitated a class discussion seeking agreement and clarifying disagreement on responses. In the video example provided, students compare time of travel of two classmates of different masses, each seated on a skateboard, pushed with constant force down the hallway (see Video segment 4). This skateboard activity was among the design changes that the first author deemed necessary during the process of implementing the curriculum (see Table 1).

UNIT/CYCLE	ACTIVITY	CHANGES
Unit 1 Building a Foundation/Cycle 2: Introducing Interactions	<i>Learning about other ideas—</i> Activity 6: Interaction between a magnet and an electric circuit	Not done to save time
Unit 1/Cycle 3: Interactions and properties	<i>Learning about other ideas—</i> Activity 7: Calculating density	Not done to save time
Unit 2 Interactions and Energy/Cycle 1: Energy description of interactions	<i>Learning about other ideas—</i> Activity 6: Describing the motion of an object with constant speed	Added hands-on component with “Speed of Toy Car” activity
	<i>Learning about other ideas—</i> Activity 7: Speed of waves	Added hands-on component with “Speed of Sound in Air” activity
Unit 2/Cycle 2: Mechanical Interactions and Energy	<i>Idea power –</i> Activity 6: Analyze, Explain, and Evaluate	Not done due to anticipated difficulty for students
Unit 3 Interactions and Forces/Cycle 1: Mechanical Interactions and Forces	<i>Idea power –</i> Activity 10: Applying Force and Energy Ideas	Not done due to anticipated difficulty for students
	<i>Learning about other ideas –</i> Activity 11: Changing Force Strength and Mass	Added hands-on component with “Skateboard” activity
	<i>Learning about other ideas—</i> Activity 12: Simple Machines	Replaced reading about simple machines with video and handout showing them
Unit 3/Cycle 2: Gravitational Interactions		Eliminated entire cycle because not in state course of study
Unit 4 Interactions and Conservation/Cycle 2: Energy Conservation	<i>Idea power—</i> Activity 8: Efficiency	Augmented reading about efficiency with video
	<i>Learning about other ideas—</i> Activity 9: Reflection of Light	Not done to save time
	<i>Learning about other ideas –</i> Activity 10: Refraction of Light	Not done to save time
	<i>Learning about other ideas –</i> Activity 11: Color	Not done to save time
	<i>Learning about other ideas—</i> Activity 12: Energy Resources	Not done to save time
	<i>Learning about other ideas—</i> Activity 13: Stars and Galaxies	Not done to save time
Unit 5 Materials and their Interactions (no more cycle headings)	<i>Learning about other ideas—</i> Activity 12: Acid, Base, or Neutral?	Added hands-on component with “pH of Household Liquids” activity
Unit 6 Physical Interactions and Phases		Eliminated entire unit with few weeks remaining in semester; introduced the “movie review project”
Unit 7 Chemical Interactions		Eliminated entire unit with few weeks remaining in the semester.

TABLE 1. Summary of Decisions and Changes Made to the *Interactions in Physical Science* Curriculum

VIDEO SEGMENT 4. Teacher-led review of students' findings from their inquiry investigation on force and mass on a skateboard.

To complete the lesson, the class revisited the “key question” and now recorded their best summary response in answering it. This part of the lesson, as viewed in the video clip from the skateboard activity, began with the individual students recording their response to the key question before the teacher reviewed responses and came up with a class response—called *Our consensus ideas*. Part of this process included comparing pre-activity responses to post-activity responses. The teacher typically saved initial “key question” responses on the Smart Board to compare with new ones. This technique promoted conceptual change to deepen student understanding (see Video segment 5).

VIDEO SEGMENT 5. Teacher-led consensus-building on final learning from student data and new thinking from the skateboard activity.

Assisting in a Challenging Curriculum

Early into the semester the teacher began making modifications to how he used the prescribed curriculum. One of these modifications was in the area of assessment. The curriculum design included end-of-cycle tests, but no other formative assessments for between cycle activities. The teacher viewed this as problematic because one to two weeks would pass before giving a culminating cycle test. In addition, these tests were often very challenging in requiring high levels of thinking that many students found difficult.

In order to compensate for initial low scores on these tests, the teacher would allocate time in class once tests were returned for students to revise their incorrect responses. Students who took advantage of this process received back partial credit for test items initially marked incorrect. In discussions with the second author (as outside co-researcher) the teacher understood the need to supplement the cycle tests with additional quiz-type assessments along the way. However, with limited time in learning and prepping materials each day for this new curriculum, he chose to not make these additions. He addressed this tension through accommodating the students in test-taking. This approach had mixed results because some students took advantage of this opportunity to re-learn what they may have missed on the tests, while other students guessed at another response. In both instances the scores still improved.

Another challenging portion of the curriculum were the application activities—called *Idea Power*. This group of activities came toward the end of each cycle and fulfilled the elaboration phase of a learning cycle. The teacher was surprised that there were very few of these activities (typically only one in each cycle). This was in contrast to the multiple exploratory activities that preceded it. He completed the first one in the curriculum that was in Unit 2, Cycle 1, Activity 5 (... *the Fabulous Wake-Up System*) because he felt it was a worthwhile hands-on application of learning about energy transfer. The challenge that many of these activities presented was in their format. Most of these application activities were an “analysis and explanation” of a given series of scenarios. The teacher viewed these scenarios as both difficult and potentially frustrating for the students as logic problems. These types of problems first arose in Unit 2, Cycle 2, Activity 6 (*Analyze, Explain, and Evaluate*). The teacher chose not to use these types of activities until Unit 4, Cycle 2, Activity 7 (*Analyzing and Explaining Energy Interactions*) when he introduced their format to the students and had them complete the remaining ones encountered in the curriculum. Later in the curriculum implementation, the teacher decided to start using the “analysis and explanation” activities because he felt that the students were better prepared to do them. When introduced, the students did complete them satisfactorily, because the learners had, at this point in the course, gained more experience with the type of thinking required in these activities.

Making Paper-and-Pencil Activities Hands-On

The teacher judiciously chose which optional activities—called *Learning about other ideas*—to complete in the curriculum based on time constraints. He particularly chose those extension activities that most related to the concepts explored and for which there were explicit state standards to be met. All of the activities in this category were strictly paper-and-pencil ones. The activities presented students with background reading, scenario/problems, and data for

them to complete the given questions. This non-hands-on approach would not allow the students to conduct first-hand inquiries or view the phenomena raised in the scenarios. The teacher was familiar with conducting some of the actual scenarios through hands-on activities. Thus, for the ones he selected to use, he made modifications for students to do a hands-on, inquiry-based version of them. For example, in Unit 2, Cycle 1, Activity 6 (*Describing the Motion of an Object...*), students pursued learning about constant speed not from the scenario and data given in the original activity but by conducting an inquiry with toy cars. See Appendix D for the inquiry activity sheet for conducting an investigation of constant speed using a toy car. Students gathered the toy car speed data for analysis.

In another lesson, Activity 7 (*Speed of Waves*), students calculated the speed of sound in the classroom from a water-jug, PVC pipe, and tuning forks instead of using the given data on sound in the original activity. See Appendix E for the inquiry activity sheet for investigating the speed of sound in air.

In Unit 3, Cycle 1, Activity 11 (*Changing Force Strength and Mass*), the students conducted the previously mentioned skateboard activity to gather data on the relationship of force, mass, and acceleration; again, in place of the given data, force diagrams, and scenarios; one of which included skateboarding. In Activity 12 (*Simple Machines*), the students watched an educational video that demonstrated the types of simple machines and how they worked. This video demonstrated what they would only read about in the original activity. And lastly, in Unit 5, Activity 12 (*Acid, Base, or Neutral?*), students used a pH indicator, observing its changing color from acid to base, instead of only reading about it and selecting appropriate answers.

The reason that the teacher made these modifications was to keep student interest in the lessons, interest and engagement that would help their learning and enjoyment of the lesson. Also, he could easily make the modifications from past experience. He also knew from past experience that middle grades students are better engaged in learning through hands-on means. The hands-on activities that he added were successfully used with his past students in the same grade, so he had reason to believe that they would again motivate and engage the students. Students responded positively to these design changes, and assessments indicated that these activities supported student learning.

Adding a Culminating Project

The *Interactions* curriculum is composed of seven units of study. During the semester, the teacher initially planned on completing all seven units, omitting the cycle on gravitational attractions. He only completed the first five units. The block schedule affording only one semester for the entire course provided less total instructional time than the traditional year-long schedule. School-wide events such

as standardized testing, field trips, and special assemblies replaced over 10 instructional days of the Spring semester. With one week of classes left in the school year, the teacher chose not to begin unit 6, but instead to guide students through a culminating movie project. He wanted the students to complete a creative project that demonstrated an area of their science learning during the semester. This project would serve as a self-reflective assessment on what was meaningful for them. Students worked in teams to plan, shoot, and edit their movies. A rubric provided guidance for how the teacher would evaluate the project (see Appendix F).

The *Interactions* curriculum provided few, if any, creative opportunities for students to apply or express their learning through means other than structured inquiry. The teacher believed that student interest in the curriculum had waned over the semester because of the routine format and predominant emphasis on inquiry and scientific processes. Yet, he wanted to consistently implement the curriculum with high fidelity to its design. As the sabbatical of teaching middle school students drew to a close, he wanted to end the semester through a different approach; one that he remembered doing in his past middle grades teaching experience. As he expected, the movie project re-excited the students' interest in the class, allowing the semester to end on a pleasing note.

REFLECTION ON CURRICULUM DESIGN

Curriculum Challenge

The *Interactions in Physical Science*® curriculum was designed to both interest and engage middle grades students in science through inquiry. To a large extent the teacher viewed it as successful in this goal. The frequent use of natural phenomena through hands-on inquiry almost always engaged the students in the learning. Students had to function at higher levels of cognition about what they knew and what they were discovering through a process of evidence-based reasoning. The nature of the learning from the structured inquiries, scenarios, practice sheets, and tests challenged the thinking of all students, but particularly the lower achieving students in the classroom. The teacher was acutely aware of this challenge early in the semester when he first used the pre-designed tests and logic-based activities. His minor modifications to testing and the use of *Idea Power* activities enabled those elements of the curriculum to be implemented for his students. Further modifications would be needed in the areas of assessment and application activities to reach a more satisfactory approach in the future. Further reflection on assessment of student learning led the teacher to decide that future implementations of the curriculum would require frequent, brief, formative assessment quizzes aligned with learning objectives for each activity. These quizzes should parallel the format used on the end-of-cycle tests.

This approach would help both the students and teacher better analyze and respond to developing understandings during the learning cycles. This would possibly lead to better outcomes on the cycle tests.

Time Needed for Relevancy

The frequent use of structured inquiry and hands-on learning in this curriculum generally promoted student interest and engagement, but did not sustain it over the semester. Part of this problem was the nature of having a predictable learning routine for middle grades students who need variety in learning for enduring interest. More importantly, the teacher noted the lack of application activities. Such activities are essential for relevance, allowing students to relate the science they were learning to personal interests and “real world” issues. This essential element, so significant to the teacher’s previous success with middle school students, seemed absent as a price paid for a curriculum design whose sole focus was to guide students in concept development via hypothetico-deductive reasoning. Past experience taught the teacher that these application activities were more than just practicing new learning; they included further inquiry into how the science was used in everyday life to benefit people, such as engineering solutions to address human needs. Related research, projects, and engineering allowed students some personal investment and creative freedom in their work.

Curriculum designers would find it difficult to do all things well and still meet required state and national standards for science education in the limited amount of time of most public school calendars. The designers saw the *Idea Power* activities as serving this purpose and place (i.e., **Elaboration**) in the Learning Cycle. These activities, as few as were present, served as a practice for what students were learning. No activities met the greater goal of the Learning Cycle in allowing students to complete activities that connected their new learning to the “real world” where it would be put into practice addressing human needs. The teacher viewed these links from his past middle grades teaching experience as important in sustaining motivation and interest in learning science.

The teacher did not initially plan additional activities for relevancy to address this portion of the Learning Cycle within the curriculum’s designed cycles. He began to feel the need to do this by Unit 2 but instead capitalized on the use of the optional learning activities to help. Where present and selected, the optional activities—*Learning about other ideas*—as extensions of learning added some relevancy to the concepts learned. Lesson topics on energy resources, speed of cars and waves, simple machines, and acids/bases of household liquids are examples of adding this relevancy to each cycle. To improve these activities for greater student engagement, he modified them from strictly reading-based

activities into hands-on activities. These modifications took little time and effort to make because of his past experience in already doing these identical activities. Time needed to prepare this new curriculum and the time needed to teach it as designed were always the teacher’s overriding concerns during the semester. These concerns are common to all teachers but particularly to science teachers who emphasize hands-on inquiry learning. In addition, maintaining fidelity to the curriculum for the sake of its evaluation was always a key factor for this teacher in making any design changes.

Inquiry and Creativity

The nature of scientific inquiry and its associated scientific practices were certainly front-and-center as a cornerstone of this curriculum’s design. Students collected data from which they used evidence-based argumentation to publically respond to the scientific questions posed in the exploratory activities. The intent of this process was to foster conceptual change by confronting students with evidence that often contradicted their initial “predictions” based on prior thinking and beliefs—termed *misconceptions* or *alternative conceptions* in science education literature (Beeth & Hewson, 1999). The use of structured inquiry where students carry out completely prescribed activities is the science teacher’s tool of choice for teaching targeted content through a scientific process. In this curriculum, it served the dual purpose of also fostering conceptual change in student thinking.

In further reflection, however, the teacher came to see the *Interactions* curriculum as too prescribed with little room for student choice and creativity. This creativity for planning and conducting scientific inquiries is an element of the scientific endeavor that should be explicitly taught. This creative choice was lacking in not having deeper applications of new learning, but also in the over-reliance on *structured* inquiry. In many inquiry-based curriculum designs this choice comes through providing opportunity for guided inquiry activities that follow structured inquiries (Martin-Hansen, 2002). These “coupled inquiries” can extend structured inquiries to further explore related questions or experimental variables of student interest. Providing more guided inquiry activities in this manner would provide more student choice in pursuing questions of interest to them by experimental design choices of their creation. In other instances, the evidence-based reasoning and discourse skills developed from structured inquiry could be applied to a broader array of science learning activities than those included in this “scripted” curriculum. Longing for these pedagogical elements, both authors, ironically, came to view the *Interactions* curriculum as “too sciency.” That is, the conceptual-change-by-deductive-reasoning objective of this curriculum seemed to squeeze out other vital dimensions of human creativity and reasoning. These dimensions include inductive/qualitative reasoning, artistic expression, engineering/design tasks, debating social issues, and a wide

variety of reading and writing opportunities, each offering great promise for engaging adolescent learners. The design changes described here represented some productive steps toward providing more avenues of student choice to vary the heavily prescribed curriculum and sustain student interest and engagement over time.

While conceptual understanding and associated cognitive gains in learning will remain the focus of science education, the *affective* nature of engaging and sustaining learning should not be downplayed. Middle school students need to be challenged but also empowered in their learning to do science and use it, so that they see the relevance to their lives. They are naturally curious and interested in the scientific endeavor, but not for its own sake, but for how science intersects with their interests, elicits their talents, and engages them in meaningful interaction with others.

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APPENDIX A

Interactions Course Content Syllabus

SECTION A: INTERACTIONS AND ENERGY

Unit 1: Building a Foundation

Cycle 1: Science Experiments

Activity 1: Measurements in Science

Activity 2: Relationships in Science

Activity 3: Good and Poor Experimental Designs

Activity 4: Evaluating Experimental Designs

Activity 5: Evaluating Experimental Conclusions

Cycle 2: Introducing Interactions

Activity 1: Evidence of Interactions

Activity 2: The Magnetic Interaction

Activity 3: The Electric Charge Interaction

Activity 4: The Electric Circuit Interaction

Activity 5: Electromagnets and Buzzers

Activity 6: Interaction between a Magnet and an Electric Current

Cycle 3: Interactions and Properties

Activity 1: Measuring “Stuff”

Activity 2: Volume of Solids

Activity 3: Volume of Liquids

Activity 4: Measuring Mass

Activity 5: Density

Activity 6: Characteristic Properties

Activity 7: Calculating Densities

Unit 2: Interactions and Energy

Cycle 1: Energy Description of Interactions

Activity 1: Interactions and Energy

Activity 2: Energy Description of Interactions

Activity 3: Mechanical Waves and Energy Transfer

Activity 4: Water, Sound, and Earthquake Waves

Activity 5: Interaction Chains, Energy Transfers and the Fabulous Wake-Up System

Activity 6: Describing the Motion of an Object with Constant Speed

Activity 7: Speed of Waves

Activity 8: Objects and Waves with Changing Speeds

Cycle 2: Mechanical Interactions and Energy

Activity 1: Notions about Motion Energy

Activity 2: Mechanical Interactions and Motion Energy

Activity 3: Following the Energy Changes

Activity 4: Elastic Interactions

Activity 5: Mechanical Interactions and Energy Transfer

Activity 6: Analyze, Explain, and Evaluate

SECTION B: INTERACTIONS, FORCES, AND CONSERVATION

Unit 3: Interactions and Forces

Cycle 1: Mechanical Interactions and Forces

Activity 1: Forever Away?

Activity 2: Pushes, Pulls, and Motion

Activity 3: A Frictionless World?

Activity 4: Friction and Backward Forces

Activity 5: What is Transferred?

Activity 6: Pushes, Pulls, and More Interactions

Activity 7: Multiple Forces and Motion

Activity 8: Forces and Direction of Motion

Activity 9: Mechanical Forces and Motion

Activity 10: Applying Force and Energy Ideas

Activity 11: Changing Force Strength and Mass

Activity 12: Simple Machines

Unit 4: Interactions and Conservation

Cycle 1: Mass Conservation

Activity 1: What Happens to the Amount of Stuff?

Activity 2: Keeping Track of Stuff in a Closed System

Activity 3: Mass and Open Systems

Activity 4: Keeping Track of Volume in a Closed System

Activity 5: Interactions and Mass

Activity 6: Mass Conservation Problems

Cycle 2: Energy Conservation

Activity 1: Energy and Interactions

Activity 2: Energy and Heat Conduction Interactions

Activity 3: Energy and Infrared Radiation Interactions

Activity 4: Thermal Energy and Phase Change

Activity 5: Conservation of Energy

Activity 6: Wrapping Up Energy and Interactions

Activity 7: Analyzing and Explaining Energy Interactions

Activity 8: Efficiency

SECTION C: INTERACTIONS OF MATERIALS

Unit 5: Materials and Their Interactions

Activity 1: Describing and Classifying Materials

Activity 2: What is it?

Activity 3: How to Use a Handheld Microscope

Activity 4: Chemical Interactions

Activity 5: Physical Interactions

Activity 6: Mixtures

Activity 7: Solutions and Chemicals

Activity 8: Classifying Chemicals Activity

Activity 9: Metals, Nonmetals, and the Periodic Table

Activity 10: Describing and Classifying Materials

Activity 11: Analyze and Explain

Activity 12: Acid, Base, or Neutral?

Activity 13: Groups and the Periodic Table of the Elements

Unit 6: Physical Interactions and Phases

Activity 1: Mental Models of What's Inside Air

Activity 2: Scientists' Theory

Activity 3: Properties of Gases, Liquids, and Solids

Activity 4: SmallParticle Theory of Gases

Activity 5: SmallParticle Theory of Liquids

Activity 6: SmallParticle Theory of Solids

Activity 7: SmallParticle Theory of a Thermal Expansion

Activity 8: SmallParticle Theory of Stored Volume Energy

Activity 9: The SmallParticle Theory of Matter

Activity 10: Explaining Properties

Activity 11: Classification Problems

Activity 12: SmallParticle Theory of Phase Changes

Activity 13: Atomic Structure

Activity 14: Atomic Structure and the Periodic Table

Activity 15: Nuclear Interactions

Unit 7: Chemical Interactions

Activity 1: What's the Model?

Activity 2: What's the Evidence?

Activity 3: Particle Interactions

Activity 4: SmallParticle Theory of Stored Chemical Energy

Activity 5: The Balancing Act

Activity 6: The Rusting Reaction

Activity 7: Balancing the Rusting Reaction

Activity 8: Energy and Reactions

Activity 9: Chemical Reactions

Activity 10: Using the SmallParticle Theory Ideas

APPENDIX B

Rewards System

Successful Team Behaviors

1. Stay on task, keep working, and keep your goal in mind.
2. Everyone must contribute, cooperate, and communicate; not just copy.
3. Listen respectfully to everyone's ideas first!
4. Do not put anyone down, but be kind and get along.
5. Read carefully and follow all given directions.
6. Think carefully before taking quick action.
7. Handle materials only as directed and clean up—Follow the Safety Contract.
8. Try to understand each other and reach agreement.
9. Be responsible and try to fix team problems, not just argue and fight.
10. Help your own team out and do not distract other team members.

Reward Options

1. Weekly Team
 - Bring snacks and drink
 - Extra credit points—not to exceed 5% of Cycle grade
 - Homework passes
2. Six-Weeks Class [Subject to Principal approval]
 - In class pizza and free seating along with...
 - movie or
 - game day or
 - listen to MP3 players
 - Field day outside

Criteria for Rewards

On a daily basis Dr. Eick will monitor team behavior. He will cite teams for violating any of the listed behaviors if observed. Citations will be noted on his weekly seating chart as 'negative points,' like a negative one number. He will also praise teams for particularly successful behaviors on the seating chart as 'positive points,' like a positive one number. Positive and negative numbers will be added at the end of the week to determine team awards. **Teams must have a positive number score, more positive than negative points, in order to earn the weekly team reward.** Each team begins with a clean slate each new week.

In order for a class to obtain the six-weeks class reward no same team can end a week with a negative score two or more times; and no two teams can end the same week with a negative score.

Criteria for Temporary Student Isolation

A student may be temporarily isolated from his or her team (as much as one week) by the team members unanimously bringing a plea for removal to Dr. Eick's attention. This plea must be supported by evidence from negative marks on the reward plan. Team members should not bring a plea for temporary removal unless they have shown that they have kindly and nicely tried to get the member in question to do better and positively contribute to the team's work. Isolated team members will complete the class work on their own, if possible, or given an alternative assignment in the textbook. Parents may be called if the isolated student does not do better when returned to their team.

APPENDIX C

Science Log Format—Activity 1

You should follow the given format in recording information in your science log notebook. You should be sure to copy all headings shown here and position them exactly as shown. Box and highlight all cycle key questions in blue; activity key questions in yellow; and underline activity titles and experiment questions. Answer the 'pencil' marked questions in complete sentences.

The following is an example for your science logbook for the very first activity we will do:

Unit 1 Cycle 1

Activity 1: Measurements in Science

Cycle Key Question: How can you tell if the conclusion from an experiment is valid?

Activity Key Question: When you measure something, can you obtain an exact value?

I Think

(Answer the question in complete sentences in your log.)

Explore Your Ideas

Experiment 1: How long does it take for a pendulum to make 10 back and forth swings?

(Record your information with proper units.)

Make Sense of Your Ideas

1. (Answer the question in complete sentences in your log after recording the number.)

2. (Answer the question in complete sentences in your log after recording the number.)

3. (Answer the question in complete sentences in your log after recording the number.)

Explore Your Ideas

Experiment 2: Repeat Experiment 1.

(Record your information with proper units).

Make Sense of Your Ideas

1. *(Answer the question in complete sentences in your log after recording the number.)*

2. *(Answer the question in complete sentences in your log after recording the number.)*

3. *(Answer the question in complete sentences in your log after recording the number.)*

4. *(Answer the question in complete sentences in your log after recording the number.)*

My Ideas

Activity Key Question: When you measure something, can you obtain an exact value?

1. *(Answer the key question with your new learning and explanations in complete sentences in your log after recording the number.)*

2. *(Answer the question in complete sentences in your log after recording the number.)*

APPENDIX D

Inquiry Activity Sheet—Toy Car

Team Names: _____

Applying Your Knowledge of Speed: Characterizing the Speed of a Toy Car 4-Point Team Graded Assignment

Guiding Question: What is the type of motion of your toy car?

Your Goal: To plan and carry out an investigation to *empirically* characterize your toy car's motion.

Your Materials: Meter stick, tape, stopwatch, toy car, graph paper, calculator, hallway or gym

You will need to produce the following for your team grade with all team members' names on it:

- (1 point) A complete data table with average values for 3 trials and uncertainty values;
- (1 point) A complete graph of distance versus time with proper title, labels, scale, plotted points;
- (1 point) A brief description of the type of motion shown in the graph; and
- (1 point) Calculation of average speed over a specified distance with all work shown.

You should divide up this work so each team member is contributing a part of it. Your teacher will look to see that each team member's personal handwriting is on each separate piece. Decide up front who will complete which part of your task by completing a four-square below:

'Graph' Person:	'Calculation of Average Speed' Person
'Written Description of Graph' Person:	'Data Table' Person:

Every team member must contribute to the planning and gathering of your data; and the running of the experiment. You may consider modeling aspects of what your teacher did with his toy car to gather data and graph 'constant speed'. However, do not assume that your toy car runs at a constant speed.

Suggested Planning Steps:

1. Observe your toy car on a test run to see how well it works and what distance it covers before you plan your experiment in class.¹
2. Choose your distance intervals (or time intervals) at which you will gather data.
3. Create your **data table** with a minimum of 3 trials or replicates for averaging.
4. Gather data with all team members contributing and helping.
5. Conduct calculations.
6. Determine **average speed** for your prescribed run.
7. **Graph** the data.
8. Describe the car's motion from the shape of the graph.

Documentation:

Keep all of your team work together in your folder with all team members name on it, including your data table, graph, written description of your car's motion, and calculation of average speed.

¹ Your teacher will need to initial off on your proposed plan before your team (and class) can leave to carry out your experiment.

APPENDIX E

Inquiry Activity Sheet—Speed of Sound

Science: Speed of Sound

By: Tom Kuntzleman and adapted by Dr. Eick

Grade Level: 8

Purpose: To determine the speed of sound.

Materials: Tuning forks, 500 mL graduated cylinders, water, metric rulers.

Introduction: Sound is a wave. The speed of any wave can be found with the equation: **Speed = frequency x wavelength**

The wavelength of a sound wave can be found by allowing the sound wave to pass near a tube. When the length of the tube is one-quarter the wavelength, the sound wave will resonate. This means that the sound wave will get stronger (louder). By finding the length of a tube that causes a sound wave to resonate, the wavelength of the sound wave can be calculated. If the frequency of the tuning fork is known, the equation above can be used to find the speed of the sound wave.

Procedure:

1. Put some water into a 500 mL graduated cylinder in 50 mL increments.
2. Tap a tuning fork on a soft object and place the fork near the opening of the graduated cylinder after adding each increment of water.
 - 3a. If the sound begins to resonate (gets louder), then adjust the water level by adding or taking away less than 50 mL amounts of water in order to increase the resonance (or volume). Use your smaller graduated cylinder (and eyedropper) to add water.
 - 3b. If the sound does not resonate, add more water then go back to step 2.
4. Measure the distance in centimeters from the top of the water level to the top of the graduated cylinder. Record this distance.
5. Convert the distance in step 4 to meters.
6. Multiply the distance recorded in step 5 by 4. This will give you the wavelength of the sound wave. (**See explanation of standing waves or harmonics in open-closed tubes**).
7. Now look at the tuning fork you used. There should be a number printed on the tuning fork. This number is the frequency of the sound wave.
9. Using speed = frequency x wavelength, calculate the speed of the sound wave. Your answer will be in units of meters/second.
10. Compare your answer to the accepted value and calculate percent error.
11. If time: Repeat the experiment using different frequency tuning forks. You should get the same speed for different tuning forks.

APPENDIX F

Evaluation Rubric

A THUNDERCATS TELEVISION PRODUCTION *What We Learned in InterActions Science this Semester* A 100-Point Grade²

Project Overview

- Students in teams of choice will make a science concepts review video of a unit/cycle from the course. **Students must choose 'wisely' because 80% of your project grade depends upon your team members and their hard work!**
- Videos will be shot outside (as a backdrop), follow a television genre segment, and last 5-8 minutes in final editing.
- Video genre choices are segments of a show that can 'stand alone' from:
 - ☐ News, Entertainment (Hollywood), Travel (Culture), Sports, Children's Show (educational), Documentary (or Docu. Drama)
 - ☐ Other with Dr. Eick's permission
- Seven possible teams of no more than four students will be formed with video equipment from the school.
 - ☐ Individuals have the option of working in smaller teams (outside of the seven possible ones), but must use their own digital camera equipment with movie capabilities (i.e., no tapes but can video).
- A detailed daily plan of work and rubric for scoring will be established and reviewed before the project begins. **Students should decide upon their teammates in advance.**
- All project members must be contributing to the final video product. 80% of the project grade will be scored for the team project; the same for all individuals. 20% of the project grade will be scored for each individual based on contribution, effort, and participation; with input from fellow teammates and daily evidence from Dr. Eick.
- Outside of class work will include bringing approved 'safe' props and costume/dress needed for the video production. No backdrops will be made because the outdoors must be the backdrop and setting for the segment.
- Work on the project will occur in school over a six-day period including tentatively:
 - ☐ Project detailed introduction and getting started (Day 1: Friday May 11)
 - ☐ Script planning and writing work (Day 2: Monday May 14)
 - ☐ Outside video shooting (Day 3: Tuesday May 15)
 - ☐ Computer lab movie-making software introduction (Day 4: Wednesday May 16)
 - ☐ Computer lab editing (Day 5: Thursday May 17)
 - ☐ Video presentations and food/drink (Day 6: Friday May 18)
- Unit/Cycle Assignments: [All areas must be assigned one per team]
 - ☐ Unit 1 Cycle 1 and Cycle 3 (*can be broken apart for additional assignments*)
 - ☐ Unit 1 Cycle 2
 - ☐ Unit 2 Cycle 1 and Cycle 2 (*can be broken apart for additional assignments*)
 - ☐ Unit 3 Cycle 1
 - ☐ Unit 4 Cycle 1 and Cycle 2 (*can be broken apart for additional assignments*)
 - ☐ Unit 5
- **Reward points, as we have been doing, will be in effect for strong team work and effort each day. The top three teams per class will be awarded prizes at the end of the project.**

Work Product Components and Points

(5 points) Completed concept paper—Day 1
(10 points) Draft of script (complete for at least 5-8 minutes)—Day 2
(5 points) Raw video footage (on cards)—Day 3
(5 points) Introduction exercise to MS-Movie-Maker with Mr. Smith—Day 4
(5 points) Final edited video submitted of 5-8 minutes—Day 5
(50 points) Video Presentation and Food-Drink—Day 6—**See rubric below.**

(20 points) Individual Participation—**See procedure below.**

²The fifth major grade for the nine-weeks after U3C2, U4C1, U4C2, and U5

Final Video Presentation Rubric (50 points):

10-19 POINTS	20-29 POINTS	30-39 POINTS	40-50 POINTS
<u>Technical</u> Far from 5-8 minutes Poor or no opening title-notes and/or music-sound Few to no transitions Few to no closing credits Few to no listing of science concepts in video	<u>Technical</u> Off from 5-8 minutes Fair opening title-notes and/or music-sound Few to no transitions Few to no closing credits Few to no listing of science concepts in video	<u>Technical</u> More or less 5-8 minutes Good opening title-notes and music-sound Abrupt transitions Some closing credits Adequate listing of science concepts in video	<u>Technical</u> 5-8 minutes Well done opening title-notes and music-sound Smooth transitions Ample closing credits In-depth written listing of science concepts in video
<u>Content</u> Few to no accurate scientific concepts addressed poorly Few to no appropriate props and dress Lack of coherent and understandable video and storyline	<u>Content</u> Few accurate scientific concepts addressed too superficially Few to no appropriate props and dress Hardly coherent and understandable video and storyline	<u>Content</u> 2-3 accurate scientific concepts addressed somewhat well Some appropriate props and dress Somewhat coherent and understandable video and storyline	<u>Content</u> 2-3 accurate scientific concepts addressed very well in drama Ample and appropriate props and dress Coherent and understandable video and storyline
<u>Creativity</u> Not original and unique Poor quality production	<u>Creativity</u> Not original and unique Fair quality production	<u>Creativity</u> Somewhat original and unique Good quality production	<u>Creativity</u> Very original and unique Exceptional quality production

Individual Participation Procedure and Rubric (20 points):

Each day of the project teams will complete an ongoing work assignment sheet where each individual's participation in carrying out and completing the project will be logged. This log will be used to determine each individual's participation score (20%) on this project. Dr. Eick will sign off each day on this sheet to verify agreements and actual completion of work by each individual. Participation points will be awarded based on the following rubric:

All assigned in class and out of class obligations and work completed =	20 points
Almost all assigned in class and out of class obligations and work completed =	15 points
Most of assigned in class and out of class obligations and work completed =	10 points
Some assigned in class and out of class obligations and work completed =	5 points

NOTE: Individuals who do not show ample documented in class and out of class work participation will not share in the project grade at all, but will receive a zero grade for this team project; and then must complete their own individual project to obtain this major grade. Excessive absences during the project will lead to an individually assigned separate project for absentee persons.

Team Folder:

All project written work will be housed in the team's classroom folder. The folder will have permanently affixed the project *Concepts Paper* and ongoing *Work Assignment Sheet*.

PROJECT WORK ASSIGNMENT SHEET (20 Individual Points)

Directions—Write notes for all daily assigned work for each person. Dr. Eick will verify each day that each person completed their assigned work by initialing in the blank provided.

	Name: _____	Name: _____	Name: _____	Name: _____
Day 1:	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—
Day 2:	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—
Day 3:	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—
Day 4:	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—
Day 5:	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—	_____ In class— _____ Out—

Additional Notes:

Science T.V. Video Concepts Paper (5 points)

- Team Members Names:
 - 1.
 - 2.
 - 3.
 - 4.

- Assigned Unit/Cycle: _____

- Selected concepts for video: *(2-3, write them out from text or logbooks)*
 - 1.
 - 2.
 - 3.

- Selected Genre for T.V. segment: _____

- Assigned Roles and Character:
 - ☐ Main actor(s) *(1-2 people)* –

 - ☐ Supporting actor(s) *(1-2 people)* –

 - ☐ Camera person *(only one)*—

- Synopsis of storyline *(one paragraph)*—

- List of props needed—

- Description of dress for each character—

STATEMENT OF VOLUNTARY PROJECT COMMITMENT

We each agree to work together and cooperate in order to complete this video production project for a major science grade. We know that our choice of group and people with whom to work has been totally voluntary on our part. We understand that this project and our grade depends upon the completion of the one team video product, which will receive one and the same grade for each of us. This grade will make up 80% of our project grade; the other 20% coming from each of our own individual effort and participation. We voluntarily choose to do our part and work hard in class to obtain a high grade. We also agree to do the minimal work at home that may be required to complete this project, especially bringing in to class the needed props and dress for videotaping it.

Signature: _____ Date: _____

Signature: _____ Date: _____

Signature: _____ Date: _____

Signature: _____ Date: _____

Name: _____ Date: _____

Television Segment of Science Project Grade Sheet

Project Work Product	Points Score Possible	Points Score Received	Teacher's Initials
Concepts Paper	5		
Draft Script	10		
Raw Video Footage	5		
Movie-Maker Exercise	5		
Edited Video	5		
Final Video	50		
Individual Participation	20		
TOTAL SCORE³	100		

Student notes and comments to Dr. Eick:

³This grade is one of the five total (U3C2, U4C1, U4C2, U5, Project) that will be averaged equally in the second nine-weeks grade for science. Place this grade on your second nine-weeks grade sheet to calculate your final second nine-week's average.