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A Model Integrated Science Guide for Junior High General Education Classroom Teachers in the Tahoma School District

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ABSTRACT

A MODEL INTEGRATED SCIENCE GUIDE FOR JUNIOR HIGH GENERAL EDUCATION CLASSROOM TEACHERS IN THE TAHOMA SCHOOL DISTRICT

by

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Teaching concepts in science that incorporated different science disciplines were studied and placed into practice at Tahoma Junior High School, Maple Valley, Washington. This form of integrated teaching was displayed in an integrated science model unit. The integrated teaching was displayed in an integrated science model unit. The integrated science model unit detailed river systems and the many different sciences that play a role in creating the river environment we see daily. Research showed students learned as well if not better in integrated science classrooms when compared to students who fulfilled the traditional sequence of science classes. Moreover, brain research suggested students' brains were able to make connections between science disciplines when dealing with an entire entity, and not by dissecting the natural environment to specific fields of interest. A sample unit framework, lesson plan and student handouts were provided within the model unit. Additionally, recommendations for implementing an integrated science curriculum were provided.

ACKNOWLEDGEMENTS

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To my husband Cinco and my daughter Laina, thank you for your patience, your understanding and your loyalty to education, to learning and to achieving all things possible. With you, I can make dreams reality.

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Chapter One

Introduction

"When you are out walking, nature does not confront you for three quarters of an hour only with flowers and in the next only with animals" (Elvin, 1977, p.29). In this quote, Elvin described the artificial way in which students have traditionally acquired scientific knowledge. Such disjointed learning was in direct opposition with current standards and benchmark's for scientific literacy. Project 2061 for example, outlined a curriculum which called for various science disciplines and thinking skills to become integrated in order to meet standards and benchmarks set forth by national and state education agencies (Bricker, 2000).

Overview

Integrated, interdisciplined, multidisciplined, thematic, connected, coordinated, blended and fused were just a few of the words used to describe a way of organizing curriculum that connected a variety of disciplines to each other (Beane, 1995; Jacobs, 1989; Lederman & Ness, 1997). Although each of these words entailed slight variations and interpretations of the same concept, the way in which the corresponding curriculum was structured to meet the needs of students were vastly different (Jacobs, 1989).

Jacobs (1989) defined interdisciplined curriculum as intentionally applying methodology and language from more than one discipline to a theme, topic, or problem. Beane (1995) suggested integrated curriculum was embedded with "problems, issues, and concerns posed by life itself" (p. 616). Similarly, Lederman and Niess (1997) referred to integrated curriculum as forming a "seamless whole" (p. 57) from a combination of subjects organized around real world issues and problems.

The concept of blending subjects with one another began with the National Reform efforts of the 1930's and 1940's (Vars, 1991). As a result of current and historical integrated curriculum efforts, research showed "[i]n nearly every instance, students in various types of integrative/interdisciplinary programs have performed as well or better on standardized achievement tests than students enrolled in the usual separate subjects" (Vars, 1991, p. 15). Vars (1991) also noted that in spite of these research findings, support for integrated curriculum has fluctuated with various educational agendas. At present, there is a resurgence of support in the educational community for a more holistic approach to curriculum, namely integrated curriculum (Lederman & Niess, 1997).

Educators, the American Association of Advancement of Science (AAAS), and the National Science Foundation (NSF) believed that some form of integrated curriculum was preferred because integration was linked with increased critical thinking skills necessary to prepare students for the national and state exams in science (Czerniak, Weber, Sandmann & Ahern., 1999; Beane, 1995; Jacobs, 1989; Lederman & Ness, 1997, Crane, 1991).

Research showed that individuals benefited from integrated curriculum because the brain constantly sought connections between previously learned information and new information (Wolfe & Brandt, 1998, Hargreaves &Earl, 1998). Research also suggested individuals processed information through patterns and connections, similar to a holistic integrated approach rather than through fragmented bits of information found in the single-subject approach (Beane, 1996). Additionally, Beane (1995) stressed that the acquisition of knowledge was best obtained in a natural way—not by arbitrarily placing bits of facts into small categories known as disciplines. Beane (1995) contended that a separate subject curriculum did not provide a continuous flow of ideas. Single subject curriculum as described by Beane (1995) was a disconnected set of facts and skills that contained no unity, or no real sense to it all. In real life, Beane (1995) noted when students faced unfamiliar situations; they did not stop to ask which part was science and which part was art.

Rationale of Curriculum Integration

Integrated curriculum was the preferred method of instruction for many educators because the amount of knowledge a student needed in order to be scientifically literate increased, whereas the hours in the school day had not increased (Brandt, 1991). In an interview with Ron Brandt (1991), Heidi Jacobs stated most of the knowledge that was gained in the world did not fit into specific disciplines, rather, knowledge cut across a variety of related disciplines. Jacobs (1989) underscored the observation that students were often unable to see relevancy and connections in a single-subject curriculum; therefore they mentally left the classroom by not participating in classroom experiences and gave up the educational value of the assignment (Brandt, 1991). Furthermore, Jacobs (1989) noted the world was not divided into separate categories; instead, there were natural overlaps between subject areas--pivotal points for students and teachers to become aware of connections.

Statement of Problem

Does integrated curriculum contribute to improving students' understanding of fundamental concepts in the core sciences? Additionally, will an integrated curriculum increase students' scientific literacy in order for them to meet national and state science standards required by the State of Washington?

Statement of Purpose

The purpose of this project was to design and implement an integrated curriculum model in the Tahoma School District #409, in Maple Valley, Washington at Tahoma Junior High School. The goals for the integrated curriculum model were to increase students' understanding of fundamental concepts in the sciences, to support national and state science standards and benchmarks, and to encourage integrated teaching practices within science by empowering teachers with the tools to design an integrated curriculum tailored to their own students' needs.

Definition of Terms

For the purposes of this project the following terms were defined:

Essential Academic Learning Requirements: common learning goals for all Washington students intended to raise academic standards and student achievement established by Education Reform Act of 1993 by the Washington State Legislature. These goals were eventually defined as the Essential Academic Learning Requirements, or what students should know and be able to do—specific academic skills and knowledge students were required to obtain in the classroom (Office of Superintendent of Public Instruction, 2002).

Integrated: a curriculum approach that deliberately links subject matter from more than one discipline to examine a central theme or experience, while emphasizing appropriate process skills. (Jacobs, Ackerman, Gilbert, Hannah, Manfredonia, Percivalle, & Perkins, 1989)

Scientific Literacy: being familiar with the natural world, aware of key science concepts, and able to use scientific thinking individually as well as globally (AAAS, 1993).

Standards and Benchmarks: criteria used to determine if a student has successfully learned the specific knowledge or skill being assessed (Office of Superintendent of Public Instruction, 2002).

Theme: unifying or underlying commonalities among disciplines or topics (Lederman & Niess, 1997).

Thinking Skills: cognitive processes that enable us to interpret information and to develop the capacity to think and learn independently (Paul, Binker, Jensen, & Kreklau, 1990).

Thinking Behaviors: a composite of many skills, attitudes and life experiences that enable an individual to make decisions as to which pattern of thinking is appropriate to various situations. (Gawith, 1999).

Scientific Method: a systematic pursuit of knowledge through a collection of observable relationships, and the formulation and tests of a hypothesis (Costello, 1992).

Assessment: to determine the amount of knowledge possessed by an individual through testing, inquiry, and questioning (Costello, 1992).

Chapter Two

Review of Literature

Integrated curriculum, rooted in the progressive educational movement of the 1930's and 1940's, has become popular again and has gained national recognition and momentum from the current educational reform movement (Ledermn & Niess, 1997). The Cold War Era brought America's performance on science standardized tests to the attention of the American public, and served as a catalyst for educational reform (Jorgenson & Vanosdall, 2002). Several reform movements initiated by America's poor performance on science standardized tests underscored the need for a curriculum that provided the connection of science disciplines, an integration of themes into subject matter, a way to teach and understand the world, and a way to reach all students (Anderson, 1995, Hurd, 2000, AAAS, 1993; Culotta, 1993; Gallagher, 2000; Kelly, 2000; Yager, 2000). In order to enhance scientific literacy in America's classrooms, several models of an integrated science curriculum were created to connect the science disciplines with the natural world in order to meet the demands of improving science curriculum (Hammond, 1993). Models of the integrated curriculum included: integrated, interdisciplined, thematic, connected, coordinated, blended and fused (Beane, 1995; Jacobs, 1989; Lederman & Ness, 1997).

Purpose of Integrated Curriculum

The purpose of integrated curriculum was to increase students' understanding of fundamental scientific concepts by incorporating thinking skills, thinking behaviors and thematic concepts that linked the science disciplines in order to increase scientific literacy and to meet national and state standards (Randle, 1997).

Many educators suggested integrated science students out-performed students of the single-subject curriculum. Whereas others claimed integrated curriculum was merely a viable alternative to traditional curriculum (Dougherty, 2000, Peter, Schubeck, & Hopkins, 1995; Richmond & Striley, 1994). Jacobs (1989) warned, integrated curriculum was not a panacea but entailed trade offs from single subject curricula.

Integrated Curriculum Models

The term "integrated curriculum" was referred to as knowledge and information from distinct sets of disciplines incorporated into one curriculum (Burton, 2001). There were several variations of integrated curriculum models including: problem-based (case study), theme-based, interdisciplined and integrated (Loepp, 1999). Each variation of integrated curriculum had similar intent: to increase scientific literacy in American education (Loepp, 1999).

Problem based," or "case study" integrated curriculum involved several disciplines that supported each other to solve real world problems or issues (Loepp, 1999). Connections between the disciplines were made when dealing with the problem or issue (Loepp, 1999). Students accumulated skills used to design and carry out an experiment to solve the problem (Richmond & Striley, 1994). For students, the problem or issue became the framework for understanding related concepts in different disciplines (Richmond & Striley, 1994).

The theme-based integrated curriculum model was designed to organize curriculum around a theme such as "change" or "systems" (Peters, Schubeck & Hopkins, 1995). Once a theme was chosen, it was then woven throughout each discipline (Peters, Schubeck & Hopkins, 1995). These disciplines then became entrenched in the theme and connections were made between the distinct subject areas (Peters, Schubeck & Hopkins, 1995). By using a theme-based approach, students learned subject matter through activities based on a theme such as systems and change (Peters, Schubeck & Hopkins, 1995). Additionally, Peters, Schubeck and Hopkins (1995) stated that thematic integration built on student schemata by introducing new information into a familiar concept.

Variations of the theme-based integrated curriculum model were extensive in schools (Greene, 1991; Loepp, 1999; Peters, Schubeck & Hopkins, 1995). A theme could have been introduced into the curriculum of an entire school, into one classroom, or into the curriculum of a team of teachers teaching various subjects and grade levels (Greene, 1991; Loepp, 1999; Peters, Schubeck & Hopkins, 1995).

The interdisciplinary curriculum model involved a team of teachers teaching a core group of students (Richmond & Striley, 1994). Each teacher taught a specific subject to a core group of students for the entire day--using block periods--which made for a less disruptive student day when a modified schedule was needed (Loepp, 1999; Skerritt, 2001). Common planning time with the other team teachers was provided in plan a curriculum which made connections between subject areas (Loepp, 1999; Skerritt, 2000).

Integrated curriculum presented students with the opportunity to uncover and to make connections between disciplines throughout the year (Dougherty, 2000). In integrated science, curriculum reflected the world as it presented itself to the student in a holistic manner (Dougherty, 2000). As a result, integrated curriculum more accurately portrayed the reality of the natural world (Dougherty, 2000 ; Dewey, 1915). A theme-based and problem-based integrated curriculum was incorporated into the curriculum to provide unifying principles across the disciplines (Dougherty, 2000).

Advantages associated with the problem-based model as reported by Loepp (1999) included high student interest, increased transfer of knowledge from the classroom to life outside of the classroom, and increased student classroom participation. Richmond and Striley (1994) found students who were involved with the integrated curriculum were more likely to work as part of a team and become involved in classroom discussions than their counterparts. Additionally, integrated curriculum students had the opportunity to deal with fewer concepts in a more in-depth manner and increased their problem-solving and decision-making skills (Richmond & Striley, 1994).

Advantages of the theme-based integrated curriculum model over non-integrated curricula included: (a) teachers were able to maintain their individual disciplines while still connecting the different subject areas, (b) teachers were able to align the curriculum with state and local standards with ease, and (c) students were able to make connections from various disciplines using set objectives for the course (Greene, 1991; Loepp, 1999; Peters, Schubeck & Hopkins, 1995).

Advantages of the interdisciplined model included: (a) traditional curriculum was supported as an individual discipline, (b) flexibility within individual curricula, themes, and concepts, (c) a team of teachers were assigned to a specific number of students that remains constant throughout the year, and (d) flexibility with the daily schedule was enhanced to better meet the needs of students (Loepp, 1999; Skerritt, 2001; Richmond & Striley, 1994).

Disadvantages associated with integrated curriculum models included finding support for teacher commitment to develop curriculum, and addressing individual curricula needs with that of integrated curricula (Loepp, 1999). Although many teachers who embarked on creating integrated curriculum had good intentions, the curriculum often failed (Jacobs, 1989). Jacobs (1989) identified two, major problems that were encountered when creating integrated curriculum. First was the lack of curricula focus; the unit became a sampling of knowledge from each discipline. (Jacobs, 1989). And second, Jacobs (1989) noted that the tension created from teachers who thought of integrated curriculum as an either/or situation, felt threatened by new views of their subject area (Jacobs, 1989). Jacobs (1989) maintained that effective integrated programs must have a well thought-out scope and sequence to encourage critical thinking skills and thinking behaviors, as well as integrated and discipline based experiences.

A further challenge for the integrated curriculum was finding a balance between the depth and breadth of integrated curriculum concepts (Dougherty, 2000). Integrated curriculum teachers were initially amazed at the sheer number of concepts the curriculum covered (Dougherty, 2000). Many teachers for a variety of reasons, including lack of broad science content knowledge and lack of understanding about the new curricula were unmotivated to change (Dougherty, 2000).

As a result of teacher fear and anxiety regarding integrated curriculum, gradual implementation was recommended for teachers, administrators and schools to become acclimated to the new science environment (Dougherty, 2000). This implementation time line included continuous teacher workshops, trainings, and seminars; science advisory meetings with stakeholders in attendance; and strong support from the school and community to enhance students' learning in science (Dougherty, 2000).

These findings directly linked to the standards and benchmarks created by Project 2061 and the National Science Education Standards (AAAS, 1993). These standards were the impetus for the science portion for the Washington Assessment of Student Learning (WASL) (Brearton, 1996; American Association for the Advancement of Science, 1993).

Effects of Integrated Curriculum

Research that supported integrated curriculum claims of increased classroom performance look to Holt High School in Michigan as a model program (Richmond & Striley, 1994). Michigan State University College of Education researchers created a science integration program that incorporated life science, earth science and physical science (Richmond & Striley, 1994). Researchers maintained the integrated curriculum model was perceived by students as more authentic and as a result students connected their learning in science to real world problems and situations (Richmond & Striley, 1994). Students in the integrated science class were asked to compare their previous science classroom experiences to their integrated classroom experience and reported, through questionnaire, they learned material more in depth and were able to make connections between disciplines previously thought as unrelated (Richmond & Striley, 1994).

Effects of integrated curriculum as noted by Ellis and Fouts (2001), Austin, Hirstein and Walen (1997), Kain (1993), Hargreaves and Earl (1998), Beane (1995, 1996), Richmond and Striley (1994), Peters, Schubeck, and Hopkins (1995), Lederman and Niess (1997), Greene (1991), and Coulson (2002) were:

- improved thinking skills
- improved mastery of content
- impacted students' approach to knowledge and learning in a positive way
- increased student motivation
- increased level of preparedness for college
- increased intellectual curiosity
- improved attitude toward school and school work
- increased achievement gains in physical, life and earth science

- improved student achievement in science

Summary

From the preceding information the following patterns emerged from the research: (a) integrated curriculum took time and considerable teacher development, (b) integrated curriculum may have increased student excitement and participation in school work, (c) integrated curriculum may have involved teachers teaming with other teachers, and (d) integrated curriculum may have increased student motivation, intellectual curiosity and student success in the sciences.

Rationale for Using Integrated Curriculum

Integrated curriculum offered an alternative to the traditional sequence of science courses (earth-science, biology, chemistry, physics) students have the option to take during their high school years (Dougherty, 2000). Washington State required a minimum of two years of laboratory science for high school graduation (OSPI, 2002). Because two years of science are required, relatively small subsets of students completed the traditional four year science sequence and were prepared to meet all the science standards by grade 12 (Dougherty, 2000). However, the Washington State Assessment of Student Learning (WASL) was administered at the end of grade ten; therefore students who chose the traditional science sequence were only partially prepared to meet standards set forth by the state of Washington (OSPI, 2002).

Additionally, a survey completed by the Biological Survey and Curriculum Studies (BSCS, survey and personal communication 1997-2000) indicated integrated curriculum reflected the reality of the natural world and better prepared students to think holistically about the complex world in which we live. Because the integrated curriculum reflected unified concepts and connections with the natural world, students thought of science as relevant and connected to their own lives (BSCS, survey and personal communication 1997-2000).

One of the goals of the AAAS (1993) is for students to become scientifically literate citizens. In order for students to become scientifically literate, students must be given opportunities to explore cross-disciplinary concepts to solve complex problems; if this occurs, it is likely students will be better prepared to deal with a complex world as scientifically literate individuals (Dougherty, 2000).

Chapter Three

Design of Project

Introduction

The purpose of this project was to increase students' understanding of fundamental concepts in the sciences. To achieve this purpose, teachers were provided with an integrated curriculum model that linked science disciplines, thinking skills, thinking behaviors and thematic concepts in order to meet national and state standards. Additionally, teachers were empowered by providing them with the tools to design an integrated curriculum tailored to their own students' needs.

Need

This project was chosen because of the increased emphasis on the Washington Assessment of Student Learning (WASL), which clearly outlined standards for what students should know and be able to do in science. An in depth analysis of current science programs in the United States indicated a lack of "…rigor and depth necessary to improve students literacy in science and help them meet these standards across the disciplines" (Dougherty, 2000 p. xii). As a result, of this analysis, the author believed the integrated approach more accurately reflected essential learning's required to achieve minimum scientific literacy standards that appear in the WASL.

By creating an integrated curriculum model for ninth grade science teachers, teachers aligned curriculum with Washington State's Essential Academic Learning Requirement's to better meet the scientific literacy needs of students.

Procedures for the Project

The author undertook the following procedures to develop an integrated curriculum model for Tahoma Junior High School:

- An extensive review and analysis of related research and literature was completed.
- An in-depth analysis of current science curricula implemented in the Tahoma School District #409 was completed.
- An analysis of the science portion of the Washington Assessment of Student Learning was conducted.
- An analysis of science Essential Academic Learning Requirements (EALR's) set for by the state of Washington was conducted.

Implementation

The integrated curriculum implemented in science classes at Tahoma Junior High School during the 2002-2003 school year was planned in three phases. The first phase involved a series of "scope and sequence" meetings with science teachers, grades seven through ten. Teachers from all grades participated in describing and analyzed current practices and alignment with Washington State's Essential Academic Learning Requirements. As a result of this analysis, teachers supported an integrated curriculum because of the wide range of topics students were asked to know and be able to do for the science portion of the Washington Assessment of Student Learning. Later scope and sequence meetings focused on revising current practices to more effectively meet the scientific literacy needs of students who were required to be successful on the WASL. Additionally, teachers were able to revise the current scope and sequence matrix to one which was more aligned with the Essential Academic Learning Requirements (EALR's).

In phase two, teachers identified specific units they wished to revamp by deliberately integrating more of the sciences into that unit. After identifying a unit, teachers established it as being appropriate to their grade level, and had the ability to be aligned with several of the science state EALR's. Teachers were then provided with an example of an integrated science curriculum unit, release time to create their integrated curriculum unit, a copy of grade appropriate EALR's, definitions of thinking skills and thinking behaviors, Tahoma School District's revised science scope and sequence matrix, and sample questions from the WASL. With these materials, teachers were asked to create integrated science lessons and units which aligned with Washington State's Essential Academic Learning Requirements.

Once teachers completed creating an integrated science unit, they were asked to continue to infuse a variety of sciences into each of their units as a way to increase students' understanding of fundamental concepts in the sciences. Additional release time was created for teachers to complete the transition from single-subject curriculum to integrated science curriculum.

In phase three, teachers implemented the integrated curriculum into their classrooms. A continual process of change from single-subject curriculum to integrated science curriculum was set in place for participating science teachers.

The curriculum designed to increase students' understanding of fundamental concepts in the sciences at Tahoma Junior High School, and which is the subject of this project, is presented in Chapter Four.

Chapter Four

The Project

The purpose of this project was to design and implement an integrated curriculum model in the Tahoma School District #409, in Maple Valley, Washington at Tahoma Junior High School. The goals for the integrated curriculum model were to increase students' understanding of fundamental concepts in the sciences, to support national and state science standards and benchmarks, and to encourage integrated teaching practices within science by empowering teachers with the tools to design an integrated curriculum tailored to their own students' needs.

This chapter includes a vision for integrated science education, grades 6-10 curriculum matrices, an integrated science curriculum framework model, an integrated science model lesson plan, and a model integrated science curriculum unit for ninth-grade science teachers in the Tahoma School District. The integrated vision for science education included beliefs and conclusions the author made based upon an examination of theory and research behind integrated science. The framework model includes targeted EALR's, assessments, content skills and teaching strategies. The integrated lesson plan included in this chapter was intended to fully assist the teacher in understanding and teaching the concepts in the lesson. Included in the lesson was background information, teaching notes, student activities, EALR's addressed, content skills covered, thinking skills and behaviors attended to, as well as student handouts and student explanations of content addressed. Accompanying the lesson plan is an integrated science model unit.

This unit consisted of student handouts, readings, and assessments intended to assist students in their pursuit to understand the concepts involved with river systems. Additionally, this model unit clearly shows the integration between biology, chemistry and geology in the river system. Fundamental science concepts targeting in the sample integrated unit were observation, analysis, classification, finding evidence, precision, attending, and persistence.

Additionally, this chapter addresses administrative support for implementing an effective integrated science program.

Integrated Science Vision

Students are best able to learn science processes and content when those subjects are approached in a manner consistent with the processes of integration. Any approach to teaching science must include as part of its foundation a base of content knowledge. An integration-based approach to science education must also be supported by a staff committed to active learning, student-directed investigations, and the pursuit of answers through diverse strategies.

The author recognized that where students pursue scientific investigations designed to answer questions, explore issues, or solve problems, they more fully utilize and develop their complex thinking skills and more readily apply thinking skills and behaviors. When students see questions and issues as significant to their current and/or future lives, or as important to their community, they become more fully engaged and motivated. Engaged and motivated students are more likely to endeavor to become involved in their communities. Given the freedom to conduct their own investigations, they are move likely to take on a degree of responsibility for their own learning and thus develop into self-directed learning in and out of school

In addition the author is committed to the implementation of a science curriculum which is in alignment with the State's Essential Academic Learning Requirements, prepares students for the Washington Assessments of Student Learning, supports scientific literacy, and encourages student development. To realize the science curriculum consistent with these various commitments, the author has outlined three key areas that describe what an integrated approach to science education should look like. Those areas include communications, collaboration, and field experiences. As relates to those key areas described below, a set of descriptors has been listed as to what teachers working toward implementation of the new curriculum will be seen doing.

Communication

When entering into the fields of science and industry, potential employees are required to have strong communications skills. Employees are expected to be capable of using those skills in a variety of formal and informal situations. As with all tools, communication skills have little use when taken out of context. Communication skills must be a focus in all subject areas, and science education, no exception, must be designed to enhance those skills, especially those that are specific to the discipline. The process of scientific inquiry and investigation through integration of the sciences requires the use of high levels of communication skills as students research, read, discuss, and write as they work to discover the answers to questions.

Recognizing the important role communications skills play in students' futures, Washington State has made them a focus of its EALR's and had designed state assessments that challenge students' communication skills within content areas such as science. The EALR's require that students have the skills to organize and express science ideas and that they use effective communication strategies and tools to prepare and present science information. As part of the assessments, students will be evaluated based upon their ability to organize their ideas as they relate to some particular science content.

Teachers working toward implementation of the Communications component of science curriculum will be seen:

- Modeling effective communications skills with co-workers and students
- Asking questions
- Listening attentively as students express their ideas
- Facilitating student discussions
- Arranging classroom furniture to support students sharing ideas
- Providing students with opportunities to record their thoughts in a written format, stressing "Organization" and "Ideas" from the six writing traits

- Encouraging student use of multimedia tools and the internet

Collaboration

As with communications skills, science and industry employers expect potential employees to be capable of working collaboratively. Science is by nature a collaborative venture; with teams of individuals working together toward common goals either directly or by sharing research and ideas. The State's EALR's require that students develop abilities necessary to do scientific inquiry. Among those skills is the ability to work collaboratively. An integrated and investigative approach to science education modeled on the scientific inquiry process itself will necessarily require student collaboration with peers, teachers, community members, and others involved in the matter being investigated. Science education which models the collaborative nature of the discipline will help prepare students for work in any field, and recognizes the importance of developing group processing skills in students.

Teachers working toward implementation of the Collaboration component of TSD's science curriculum will be seen:

- Modeling collaboration in their work with other educators
- Directly teaching group processing skills
- Providing students with opportunities to experience the various group processing roles
- Arranging classroom furniture in a manner conducive to group work

- Encouraging an atmosphere where students are receptive to diverse ideas and diverse group members

Field Experiences

Science may be defined as the study of the natural world. A personal relationship with, and thus a deeper understanding of, science concepts can be developed by students engaged in investigations conducted outside the classroom, out in that natural world. A fully implemented integrated model of science education will provide students with those opportunities.

Teachers working toward implementation of the Field Experiences component of the science curriculum will be seen:

- Modeling curiosity and respect for nature
- Utilizing outdoor education sites
- Arranging for students to have field experiences
- Working collaboratively with local citizen groups, businesses, agencies, etc. that conduct work in the natural environment
- Engaging students through the exploration of local environmental issues

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Secondary Science Curriculum Units

Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
What is science and how do scientists work? (Systems, Cycles, Relationships)	**What role can science play in resolving natural resource issues? (Resources)**	**How do forces and energy influence our lives? (Forces and Energy)**	**What role do systems play in our lives? (Systems)**	**How do change and evolution affect our lives today? (Equilibrium and Change)**
Intro to Inquiry: - Scientific Investigations - Tools	Intro to Inquiry: - Matter - Elements - Scientific Procedures	Intro to Inquiry: - Reactions - Molecules - Scientific Procedures	Intro to Inquiry: Navigational Mapping	Intro to Inquiry: Space Technology
How do we use science to answer questions about our world? - Experiments with Plants	How clean is clean? - Earth Systems - Water Pollution	How can the world stay turned on? - Electricity - Light - Natural Resources	How do geological forces shape the Pacific Northwest? - Plate Tectonics - Physics	How did the Universe get to be the way that it is? How did the Earth system get to be the way that it is?
How can we accurately predict our weather? - Instruments - Forecasting - Project WET: Water Cycle	Why is biodiversity important? - Adaptations - Biomes	How has technology changed our view of the universe? - Astronomy - Telescopes - Forces and Motion	How do weather systems impact our lives in the Pacific Northwest? - Instruments - Forecasting - Extreme Weather	How concerned should we be about UV exposure?
How can we care for our Puget Sound Marine Environment? - Waves and Tides - Ecology - Marine Life	How can we best manage our forest resources? - Classification - Food Chain - Food Web	Who are we and how do we survive? - Genetics - Ecology - Environmental Forces	How healthy is our watershed? - Water Cycle - Cedar River	What is the impact of global warming on plants and animals?

River Systems Project Table of Contents

Instructional Framework

Class: Inquiry Science Nine   Unit: River Systems   Teacher: Ms. Delgado   Unit Length: 14 Days

Factors to consider:
- Student' knowledge and experience of river systems
- Level of student achievement and student trust
- Weather conditions before and during the river field experience
- Student knowledge of inquiry science investigations

Essential Learning's
What will students know and be able to do?
- 1.1: use properties to identify, describe, and categorize substances, materials, andobjects, and use characteristics to categorize living things
- 1.2: recognize the components, structure, and organization of systems and the interconnections within and among them
- 2.1 develop abilities necessary to do scientific inquiry
- 2.2: apply science knowledge and skills to solve problems or meet challenges
- 3.1: understand the nature of scientific inquiry
- 3.2: know that science and technology are human endeavors, interrelated

Assessment
What will students do to show what they know?
- Complete an inquiry investigation regarding the health of the Cedar River
- Students will present a hypothesis, results and conclusions based on an in depth field analysis of the Cedar River
- Quizzes
- Tests
- Journal
- Group Reflection

Objectives: What is the life-long learning benefit for a student participant?
- Students will use the scientific method to discover the health of the Cedar River in Maple Valley.
- With this awareness, students will be able to make informed decisions regarding their behavior and the behavior of others
- Students will know and be able to complete investigations with one another and from year to year to determine the health of the river system. (Cedar River data site: http://dnr.metrokc.gov/wlr/watersheds/cedar-lkwa.htm)

Content
- Scientific Method
- Chemical, biological and geological factors that contribute to the health of a river
- Classification of benthic macro invertebrates
- Analysis of data retrieved at the river
  1. *Biology*—BMI data collection (biotic index rating)
  2. *Chemistry*—Chemical tests (water quality index rating)..
  3. *Geology*—river topography/observation (observational data)
  - A river system's health is based on factors that incorporate the physical, biological and chemical features of the watershed. All three sciences contribute to the health of the river
- Hydrologic Cycle

Activities and Instructional Strategies
How do I design the learning opportunities to allow all students to learn?
- Field experiences
- Practice labs and field testing techniques
- Jigsaw
- Demonstration/modeling
- Research
- Multiple intelligences teaching strategies
- Connect the science disciplines to life experiences/ problems and questions
- Connect the Cedar River to students' lives
- Paired reading
- Homework
- Visuals/Graphics

Thinking Skills
- Observation
- Inference
- Classification
- Analysis

Thinking Behaviors
- Attending
- Persistence
- Precision

Resources
Contact People
- Ralph Ness (Seattle Public Utilities)
- Chris Holland 206) 615-083 I Cedar River Watershed Educational Center
  Sally Lutrell-Montes (Mountains to Sound Gateway Educational Trust)

Lesson Plan

Angela Delgado Science: Inquiry Nine Cedar River Watershed Data Analysis	**Lesson Focus**
Lesson Title: Post-data collection, Cedar River analysis—determining the health of the river **EALR's Addressed**: 2.2 apply science skills to answer a question; 1.2 Recognize the components and organization of systems and the interconnections within and among them **Implementation Time**: 2, 105 minute periods Resource(s): Ralph Ness (Seattle Public Utilities), Sally Lutrell-Montes (Mountains to Sound) **Materials**: chemical test result data completed at the river, biological data collected at the river, student handouts	❑ **Content Knowledge:** Watershed Data collection Data analysis ❑ **Content Skill(s):** Data analysis Problem solving ❑ **Thinking Skill(s):** Analysis Observation Problem solving ❑ **Thinking Behavior(s):** Attending Persistence

Learner Outcome(s): What will happen for learners as a result of this lesson?

- The student will be able to determine the health of the river using data collected at the river.
- Student will observe an interaction between the chemistry and the biology of the river to uncover the health of the river.

c	**Teacher Direction**	**Activity/Teaching Notes**
5 minutes	Instruct students to gather their chemical and their biological data from the Cedar River.	Activities: • Students gather river data and place it on their desks.
15 minutes	Inform students of the importance of testing variety of factors to determine the overall health of the river. Inform students of the thinking	Activities: • Students are to take notes on the rationale for testing a variety of factors at the river to determine overall health of the river system

	behaviors and skills they will be using throughout the lesson (attending, persistence, analysis, observation and problem solving) explain strategies and pass out strategy charts. Students are familiar with these strategy charts so the goal is for students to be cognizant of the thinking behaviors and skills they are using to complete the unit.	• Students, with their table partners, discuss, and create a table paper • Table paper should include the reasons why it is important to study multiple factors to determine the health of a river. • Collect thinking behavior and thinking skill strategy chart. Review strategy and skills in order to complete the graphic organizers.
45 minutes	Inform students of the water quality index rating and what they can interpret from the rankings. Instruct students of the importance of accuracy when calculating the results. Any error could invalidate the results. All members of the group must calculate the data individually and then compare to make sure analysis is accurate. Teach students how determine the Q-value (handout #1) and then, to calculate the water quality index (handout #2) Students calculate the WQI.	<u>Activities:</u> • Students listen to directions and take notes on the water quality index (WQI) definition and calculations • Students complete the WQI calculations by first converting raw data into Q-values, from there, multiply by the weighting factors to get the WQI (handout #1).
45 minutes	Describe to students how to determine the biotic index (BI).	<u>Activity:</u> • Students listen and discuss why it is important to study multiple factors to determine the health of a river. community in a stream and are an important link in the aquatic food chain, the algae and

		leaves that grow and fall into the stream are eaten by BMI's and the BMI's are also a source of energy for large animals such as fish, which in turn are a source of energy for birds, raccoons, bears and even fishermen. • To determine the biotic index of the stream, add the number of species of BMI's collected in the sensitive group and multiply by 3, then add the number of species of BMI's in the somewhat sensitive group and multiply by 2, then add the number of species collected in the tolerant group and multiply by 1. Add all values together for a total index value. If the number is greater than 22, the value is excellent, 17-22 good, 11-16 fair and less than 11 indicates a poor rating.
5 minutes	Describe the potential conclusions form BMI data Explain to students, this is why it is important to take and integrated (holistic) look at the stream conditions	<u>Activity:</u> • Students begin to make their conclusions based on data collected at the river. Each group will place their results on the white board when they have analyzed their data for comparison
15 minutes	Conclusion: Students analyze information from the river on an analysis graphic organizer. After students complete the graphic organizer, they are to answer the four questions regarding the health of the river in their student journals.	<u>Activity:</u> • Analyze the Cedar River data using the analysis graphic organizer • Students are to answer the following questions regarding their conclusions of the health of the Cedar River once they have completed the analysis graphic organizer. 1. Based on your analysis, what can

		you conclude about the Cedar River sampling site? 2. Based on your analysis, what can you NOT conclude about the Cedar River sampling site 3. What are some further questions you could ask to further your investigation? 4. Explain how the chemistry and the biology of the river interact with one another.

Background Information for lesson title: Post-data collection, Cedar River analysis—determining the health of the river

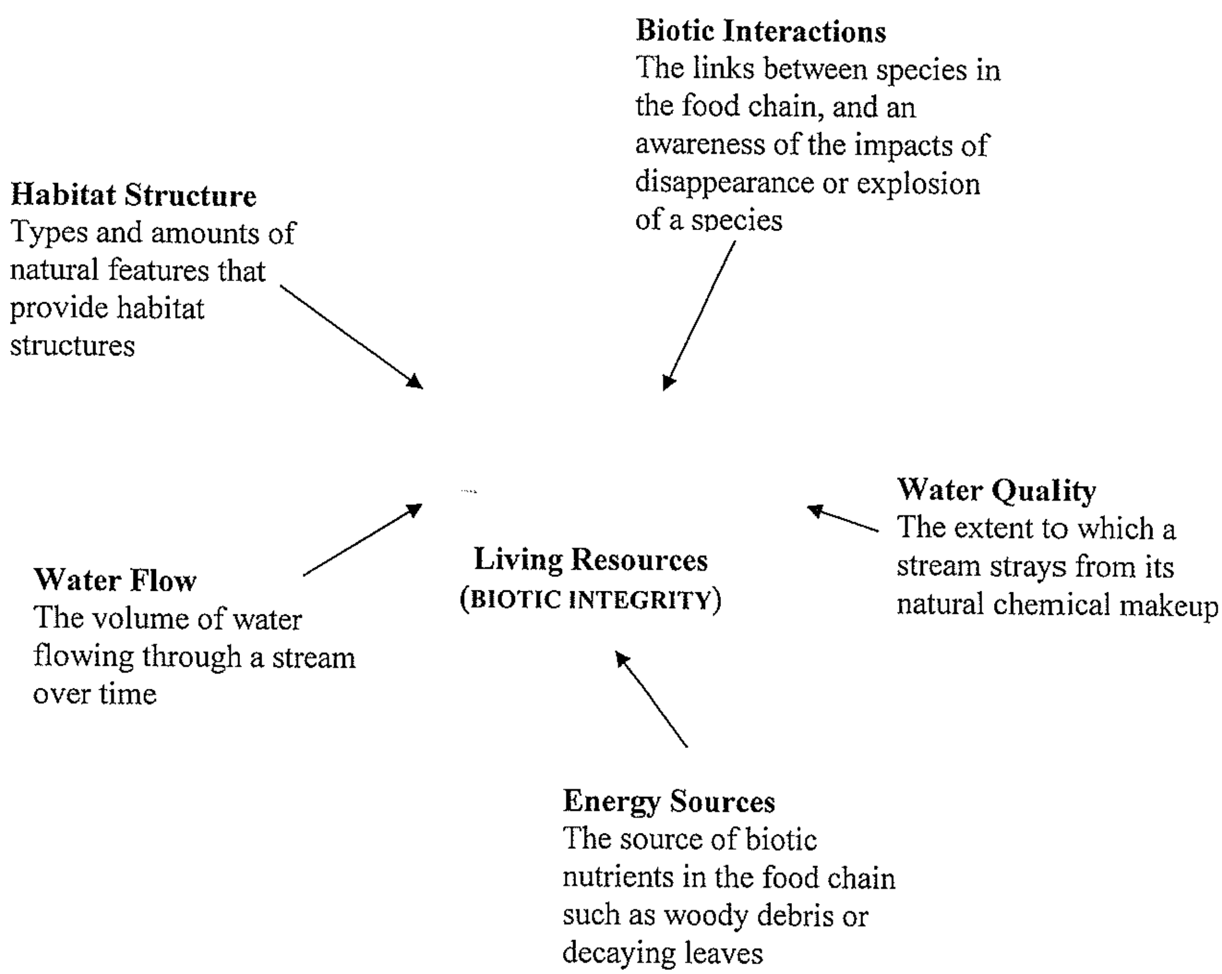
During the River Systems Unit, we are focusing on the overall water quality of the Cedar River. To do this, we must take into account the entire stream community on a holistic level, including the chemical, physical and biological factors that contribute to stream quality. With this holistic approach, a more comprehensive view of our stream comes into focus.

The lesson plan that follows details instructions to determine the water quality index (chemistry) and the biotic index (biology) of the stream. Each index reading alone does not indicate a pollution problem or lack there of, however when both index ratings are taken into account; one can draw more accurate and comprehensive conclusions. Using both sets of data, students are able to determine inconsistencies, patterns, and conclusions about the Cedar River sampling site.

In this lesson students' objective is to determine the health of the river. In order to meet this objective, students must determine the health of the river at two different levels; at the chemical level and at the biological level. Although the chemistry and the biology data analysis are distinct, it is evident that the chemistry of the river directly affects the biology of the river—allowing students to make coherent connections between the sciences, thus integrating the sciences.

When determining the health of the river, stream monitoring groups and the EPA take into account five different factors that contribute the biological integrity (the living resources) of the river. The five factors include: water quality, habitat structure, energy (nutrient) sources, stream flow and biotic interactions (food chain). These factors integrate the entire river system including the sciences of chemistry, biology and geology. Any breakdown of these factors could indicate a problem somewhere in the system. The goal of the holistic approach is to treat the causes of the problem, not just fix the symptoms.

Below is a diagram of a five factor approach to river systems. This approach incorporates the sciences in a cohesive manner in which students can make connections between the sciences to solve a single problem.



Teaching notes for lesson title: Post-data collection, Cedar River analysis—determining the health of the river

Rationale for testing multiple factors to determine the health of the Cedar River Sampling site.

- Explain to students, that our class is taking a holistic approach to determine river health by looking at the entire ecosystem within and around the river. With a holistic approach we are more likely to have a comprehensive and accurate view of the Cedar River.
- Because of the holistic approach to determining the health of the river, we will test and analyze the benthic macro invertebrates of the Cedar River as well as the chemicals.

Details regarding what the Water Quality Index ratings, their meaning, and the conclusions that can be drawn from these ratings

- The water quality index is a means to summarize large amounts of water quality data into simple terms (e.g. good) for reporting to the public in a consistent manner.
- The WQI provides the non-expert with a way of understanding the summary of the water test data.
- The number produced by the index means that water quality can be compared from one community to another. The WQI is expressed in a single number by integrating measurements of nine water tests: temperature change, dissolved

oxygen, biochemical oxygen demand, pH, total phosphates, total solids, fecal coliform, nitrates, and turbidity.

- After the nine water quality tests are completed, the WQI for the sample site may be calculated by converting each data set into a Q-value. The Q-value is a mathematical function that allows the water test results to combine into one value. Each Q-value is multiplied by a weighting factor to provide a measure of the relative importance that each of the nine water tests contributes to the overall water quality.
- Water quality index rankings are expressed in terms of excellent, good, medium, bad and very bad. Ranges are: 90-100 Excellent (conditions very close to natural or pristine levels), 70-90 Good, 50-70 Medium, 25-50 Bad, and 0-25 Very Bad (conditions are almost always threatened or impaired)
- It is important to note that the WQI ranking aloe should not be used to make decisions to clean up a body of water; rather, rankings that are less than excellent should be an indication for further investigation.

<u>Benthic macro invertebrates (BMI's) definition, and how BMI's are affected by the water in a stream or river</u>

- Benthic Macro Invertebrates (BMI's): BMI's are organisms that live in a stream and are directly affect by the quality of the water in the stream. BMI's are bottom dwelling (benthic), they are large enough to be seen (macro) and they are without backbones (invertebrates). BMI's are viewed as indicator organisms, which mean we are able to interpret the recent history of a stream based on the presence of BMI's.

- BMI's are good indicator organisms because they are sensitive to physical and chemical changes in their habitat, they cannot easily escape pollution in their environment, and they are easily collected and classified.
- We collected BMI data because it may be difficult to identify stream pollution with water analysis on its own. Water analysis can only provide information for the time of the sampling. Even the presence of fish and other animals may not provide adequate information about a pollution problem because fish and other animals can move away to avoid polluted water and then return when conditions improve. However, most BMI's cannot move to avoid pollution which is why they may provide us with information of a past and present pollution occurrence.
- There are a variety of BMI's, some of which are tolerant to pollution, others cannot tolerate any pollution. In a healthy stream, the BMI population will include a variety of pollution sensitive and pollution tolerant species. In an unhealthy stream, there may be only a few types of pollution sensitive BMI's present.
- The data collected from the BMI's can also lead to conclusions about the river's present or future biological integrity. For example, BMI's are an important part of the community in a stream and are an important link in the food chain. The algae and leaves that grow and fall into the stream are eaten by BMI's and the BMI's are

also a source of energy for large animals such as fish, which in turn are a source of energy for birds, raccoons, bears and even fishermen.

- To determine the biotic index of the stream, add the number of species of BMI's collected in the sensitive group and multiply by three, then add the number of species of BMI's in the somewhat sensitive group and multiply by two, then add the number of species collected in the tolerant group and multiply by one. Add all values together for a total index value. If then umber is greater than 22, the values is excellent, 17-22 good, 11-16 fair, and less than 11 indicates a poor rating.
- The absence or presence of a particular animal species in an aquatic community can often indicate much about the physical conditions and general quality of the habitat. Specifically what it indicates, we are not always sure. Certain species or taxonomic groups have rather specific tolerances to physical and chemical properties of their habitat, such as temperature, dissolved oxygen content, degree of siltation, stream velocity, degree of pollution, etc. Understanding these relationships is very important information to understand the impact of our actions on the environment.

Student Handouts

1. Q-value worksheet
2. Water Quality Index Data Sheet
3. Stream Study Record and Assessment
4. Problem Solving Graphic Organizer
5. Observing Graphic Organizer
6. Table Paper Rationale and Process
7. Analysis Graphic Organizer

Worksheet to determine Q-Values for each of the Nine Water Quality Tests

The water quality of the Cedar River Watershed is determined by examining their various physical, biological and chemical factors. These perimeters, nine in all, are collected at the Cedar River Sampling site. The various tests examined are listed below:

1. The milligram or parts per million of oxygen dissolved (DO) in the river water (used to determine the per cent saturation of oxygen dissolved in the water)

2. The number of fecal coliform colonies of bacteria that are found in a 100 milliliter water sample of the river

3. The pH of the river water

4. The Biological Oxygen Demand of the water

5. The temperature of the water at the site (used in determining the per cent saturation of oxygen dissolved in the water) and at a location one mile upriver

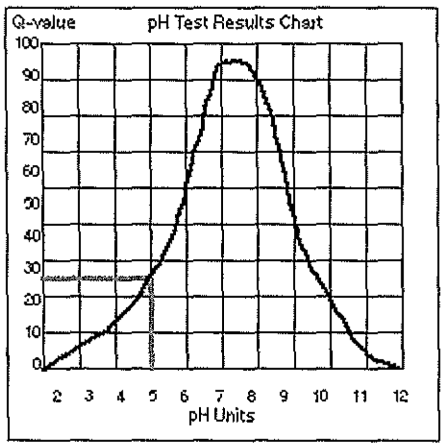
6. The total phosphates, measured in mg/liter, that are found in the water

7. The concentration of nitrates, measured in mg/liter, found in the river

8. The turbidity of the river water

9. The amount, measured in mg/liter, of total solids, suspended and dissolved, that are found in the water

After the completion of each test, the result is transferred to a water quality curve chart where a numerical Q-value is obtained. This numerical value represents the river's water quality based upon that special factor. The charts below show the water quality curve for pH and the water quality grading scale. For example, if the pH of the river had been measured as 5, this would be read as a water quality value (or Q-value) of 26 based on the graph. Using the grading scale, this indicates bad water quality.



Sample Q-value chart

Grading Scale

Q-Value	Water Quality	Grade
90-100	Excellent	A
70-90	Good	B
50-70	Medium	C
25-50	Bad	D
0-25	Very Bad	F

Q-value Grading Scale

After completing the nine tests and determining the water quality value or Q-value for each perimeter, these values are next transferred to the table below to determine the site's water quality. Since some factors are more critical than others, the Q-values are multiplied by a weighting factor. These are listed in the table below. The sum of these new products formulates the overall water quality grade for the site sampled.

Overall water quality index number value chart.

Test	Description	Q-Value	Weighting Factor	Total
DO Sat.	per cent saturation of oxygen dissolved in the water	-	0.17	-
Coliform	colonies of fecal coliform bacteria / 100 ml of water	-	0.16	-
pH	units based on the pH scale	-	0.11	-
BOD	oxygen (mg/l) used by decomposers during 5 days period	-	0.11	-
Temp. ^	temperature (C) difference between site and 1 mile upriver	-	0.11	-
Phosphate	total phosphate in mg/liter	-	0.10	-
Nitrates	nitrates measured in mg/liter	-	0.10	-
Turbidity	depth light penetrates water by using a secchi disk	-	0.08	-
Solids	the weight (mg/l) of suspended and dissolved substances	-	0.07	

Overall Water Quality Index Number and Rating____________________________.

Stream Study: Sample Record and Assessment

Stream ______________________ Site Number ___________

County or city ____________________ State ______________

Collection date ________ Collectors ______________________

Weather conditions (last 3 days) ___________________________

Average depth at site __________ Average width at site __________

Stream-water temperature F° ______ C° ______

Stream-flow rate ☐ High ☐ Normal ☐ Low

Stream appears ☐ Clear ☐ Cloudy ☐ Muddy

Macroinvertebrate Count

Sensitive	Somewhat Sensitive	Tolerant
☐ ____ caddisfly larvae	☐ ____ beetle larvae	☐ ____ aquatic worms
☐ ____ hellgramite	☐ ____ clams	☐ ____ blackfly larvae
☐ ____ mayfly larvae	☐ ____ crane fly larvae	☐ ____ leeches
☐ ____ gilled snails	☐ ____ crayfish	☐ ____ midge larvae
☐ ____ riffle beetle adult	☐ ____ damselfly larvae	☐ ____ lunged snails
☐ ____ stonefly larvae	☐ ____ dragonfly larvae	
☐ ____ water penny larvae	☐ ____ scuds	
	☐ ____ sowbugs	
	☐ ____ fishfly larvae	
	☐ ____ alderfly larvae	
	☐ ____ watersnipe larvae	
boxes checked x 3 = ______ index value	boxes checked x 2 = ______ index value	boxes checked x 1 = ______ index value

WATER QUALITY RATING ☐ Excellent (>22) ☐ Fair (11-16)

Total Index Value = ______ ☐ Good (17-22) ☐ Poor (<11)

Problem Solving Graphic Organizer

Situation:			
Define the Problem	**Problem:**		
Invent Alternatives	Alternative 1	Alternative 2	Alternative 3
Critique Alternatives	Pros:		
	Cons:		
Execute the Plan	**Proposed Solution and Plan:**		
	Reasons:		

Observation Graphic Organizer

See	Touch	Smell	Hear	Taste

Table Paper for Small Group

Definition and Rationale

A table paper is a piece of paper used by a small group to capture thier groups researching of a topic. Table papers can be created and completed in a single group meeting or in a series of meetings over time. Because the paper is large and public, group members and the instructor can monitor progress at a glance.

Process for Using Table Papers

Questions we ask when collecting and organizing information:

- What is our topic or task?
- What is our purpose in exploring this topic?
- Who is our audience?
- What is important for them to know?
- What are our resources?
- How will we report our findings?
- How will we organize our material and presenters for the strongest impact
- How will we assess our audiences understanding?

When working with a group, remember to: share ideas and brainstorm bolding, paraphrase, ask clarifying questions, encourage other members, stay on task, communicate effectively and create a quality product.

Analysis

Breaking into Parts to Determine Meaning

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Analysis

P:\TEACHING & LEARNING\GRAPHIC ORGANIZERS (WORD)\ANALYSIS.DOC

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Answer the following questions in your journal after you have analyzed the data and completed the analysis graphic organizer.

1. Based on your analysis, what can you conclude about the Cedar River sampling site?
2. Based on your analysis, what can you <u>NOT</u> conclude about the Cedar River sampling site
3. What are some further questions you could ask to further your investigation?
4. Explain how the chemistry and the biology of the river interact with one another.

Integrated Science Unit:
River Systems

River Systems

Objective: Students will use the scientific method to discover they have the ability to make decisions that affect not only themselves, but the entire environment in which we all live. With this awareness, students will be able to make informed decisions regarding their behavior and the behavior of others.

River System Unit Objectives

<u>Objective</u>: Students will use the scientific method to discover they have the ability to make decisions that affect not only themselves, but the entire environment in which we all live. With this awareness, students will be able to make informed decisions regarding their behavior and the behavior of others.

Lets Play! <u>This game is intended to get to you think about river systems</u>. To play this game you will need one die and someone to roll the die. Roll the die, whatever the number is on the die, is the question you answer. Answer all questions. If you roll the same number twice, roll again until you have a different question to answer. You have completed the game when you have answered all six of the questions.

Topic: River Systems

1. List as many questions you have about this topic as possible.

____

____

2. Invent two difficult questions about this topic.

____

____

3. What might be the most interesting thing about this topic? What might be the most boring this about this topic?

____

____

4. List one thing you already know about this topic.

____

____

5. What interesting steps could you take to learn about this topic? List at least three ways.

____

____

6. List at least three reasons why it is important to learn about this topic.

____

____

River Systems Unit Overview

During the River Systems Unit, we are focusing on the overall water quality of the Cedar River. To do this, we must take into account the entire stream community on a holistic level, including the chemical, physical and biological factors that contribute to stream quality. With this holistic approach, a more comprehensive view of our stream comes into focus.

The objective of the River System Unit is to determine the health of the Cedar River. In order to meet this objective, students must determine the health of the river at two different levels; at the chemical level and at the biological level. Although the chemistry and the biology data analysis are distinct, it is evident that the chemistry of the river directly affects the biology of the river When determining the health of the river, stream monitoring groups and the EPA take into account five different factors that contribute the biological integrity (the living resources) of the river. The five factors include: water quality, habitat structure, energy (nutrient) sources, stream flow and biotic interactions (food chain). These factors integrate the entire river system including the sciences of chemistry, biology and geology. Any breakdown of these factors could indicate a problem somewhere in the system. The goal of the holistic approach is to treat the causes of the problem, not just fix the symptoms.

Below is a diagram of a five factor approach to river systems. This approach incorporates the sciences in a cohesive manner in which students can make connections between the sciences to solve a single problem.

Water Quality

The extent to which a stream strays from its natural chemical makeup

Habitat Structure

Types and amounts of natural features that provide habitat structures

Water Flow

The volume of water flowing through a stream over time

Living Resources

(BIOTIC INTEGRITY)

Energy Sources

The source of biotic nutrients in the food chain such as woody debris or decaying

Biotic Interactions

The links between species in the food chain, and an awareness of the impacts of disappearance or explosion of a species

The Science of River Systems

In order to determine the river's health, there are three main factors we must look at: (1) the chemistry of the river, (2) the biology of the river, and (3) the geology of the river. All of these factors interact with one another to create a cohesive environment throughout the entire watershed, from the headwaters to the lower reaches.

Chemistry: When we look at the chemistry of the river, we will be testing the water for temperature, pH, dissolved oxygen, biochemical oxygen demand, phosphates, nitrates, chlorine, turbidity, total solids, and fecal coli form. From these tests, we should be able to determine the river's overall Water Quality Index, or WQI. This is only one step however, to determine the health of the river.

Biology: The biology of the river is the life that is in and that surrounds the river. We will be observing the riparian zones around the river as well as the Benthic Macro Invertebrates (BMI's) in the water. The BMI's can tell us a great deal about the pollution levels of the rivers because of the BMI's short life cycle, their relatively sedentary life, and their habitat—they live at the bottom of the river. After we collect samples of the BMI, we can then determine the biotic index. The biotic index is another indicator of stream health.

Geology: To learn about the geology of the river we will be mapping the river as well as taking rock and soil samples. From these samples we will be able to determine what type of rocks are deposited in the river—glacial debris, evidence of volcanic eruption, and from the mapping we will be able to determine the flow and velocity of the river water. It is from this mapping that we will be able to determine the topography of the river, and thus its rate of flow. The topography of the river is the last strand in determining the health of the river.

With all three interacting factors, one is able to determine the overall health of a river or stream with certainty (if results are consistent).

We are taking a holistic approach to determine river health by looking at the entire ecosystem within and around the river. With a holistic approach we are more likely to have a comprehensive and accurate view of the Cedar River.

Because of the holistic approach to determining the health of the river, we will test and analyze the benthic macro invertebrates of the Cedar River as well as the chemicals.

Water Quality Index Information

The water quality index is a means to summarize large amounts of water quality data into simple terms (e.g. good) for reporting to the public in a consistent manner.

- The WQI provides the non-expert with a way of understanding the summary of the water test data.
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Water Quality Index

Read each of the water quality test descriptions and complete the table completely.

Test Name	Measures?	Units	Why do we do this test?	Healthy Range	What effects the test?

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Biotic Index

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Benthic Macro Invertebrates Information

Read about BMI's and their characteristics as indicators for a healthy stream. Highlight, underline and make notations in the margins. write down notes describing important facts and issues about BMI's. Use the following note taking guide as a helpful hint to what is important and what material you should read carefully and understand completely.

BMI's—What are they?

BMI's as indicators of stream health—Why are they indicators? What do BMI's do to become indicators?

Macro-invertebrates Classification—How? Kingdoms? Phylum's?

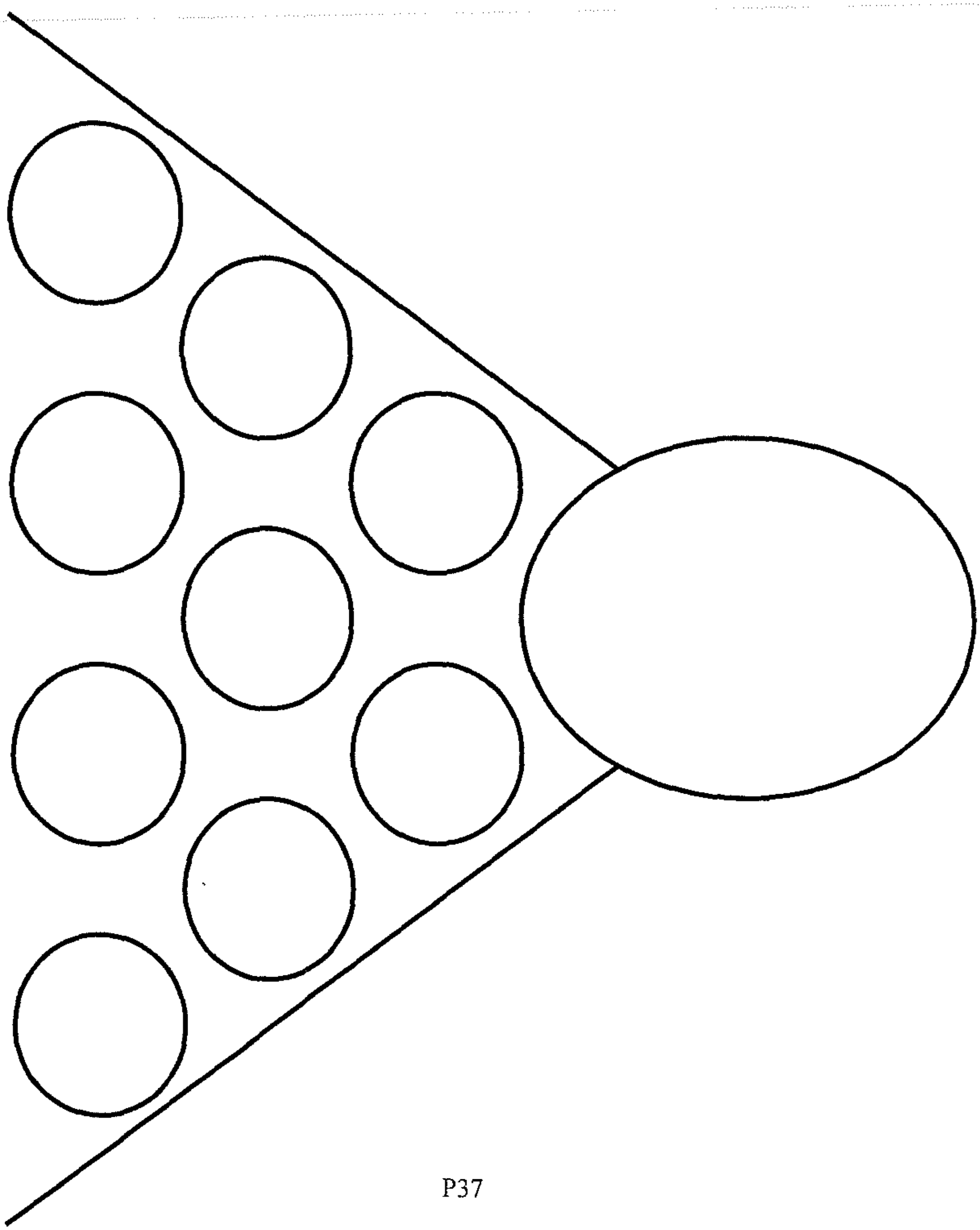
Morphology—What are the different parts of a BMI?

Life Cycle of BMI's

Feeding Groups—What does each group do and where are they found?

BMI's

Read about BMI's and their characteristics as indicators for a healthy stream. Highlight, underline and make notations in the margins. Summarize each section of the BMI information.



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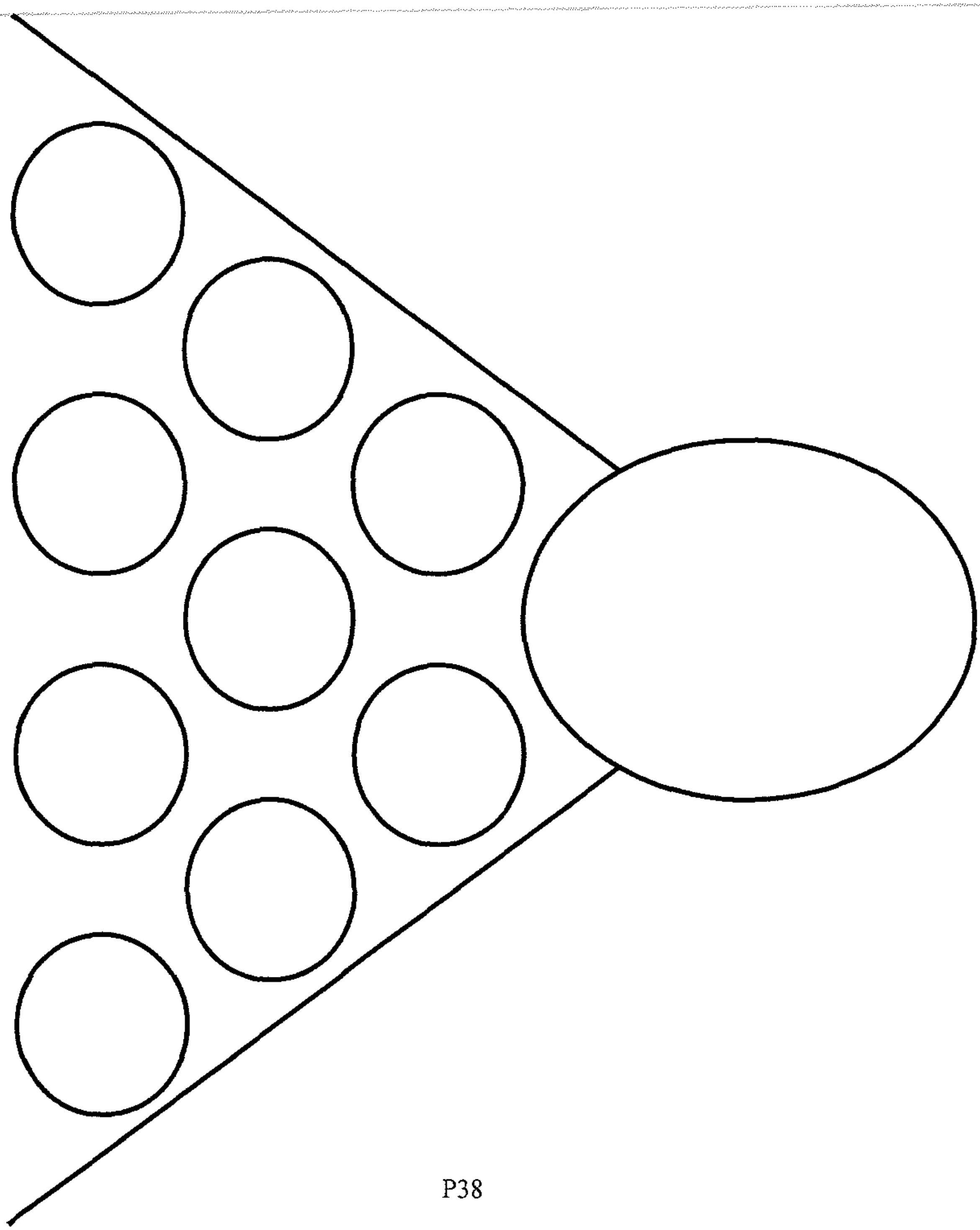

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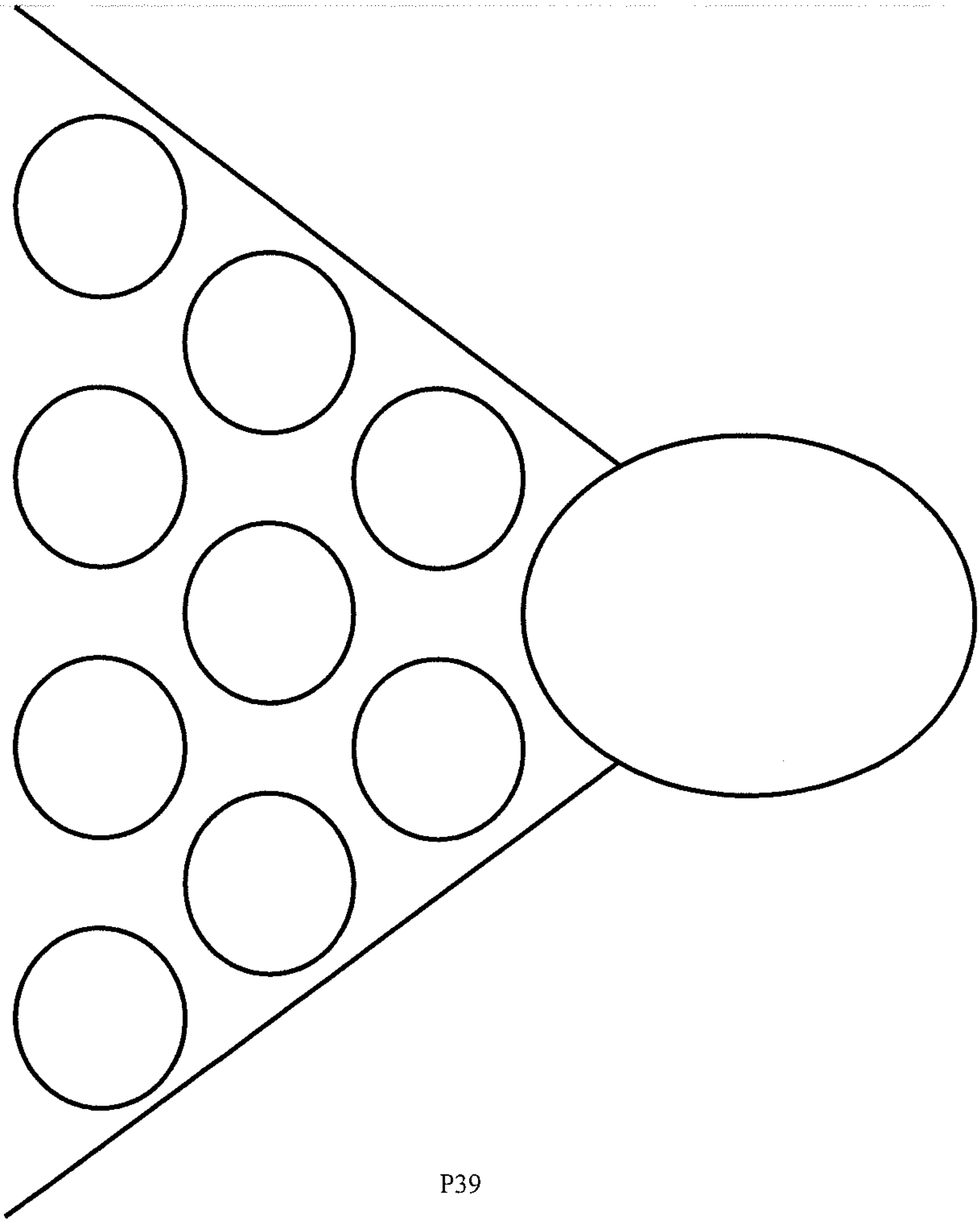

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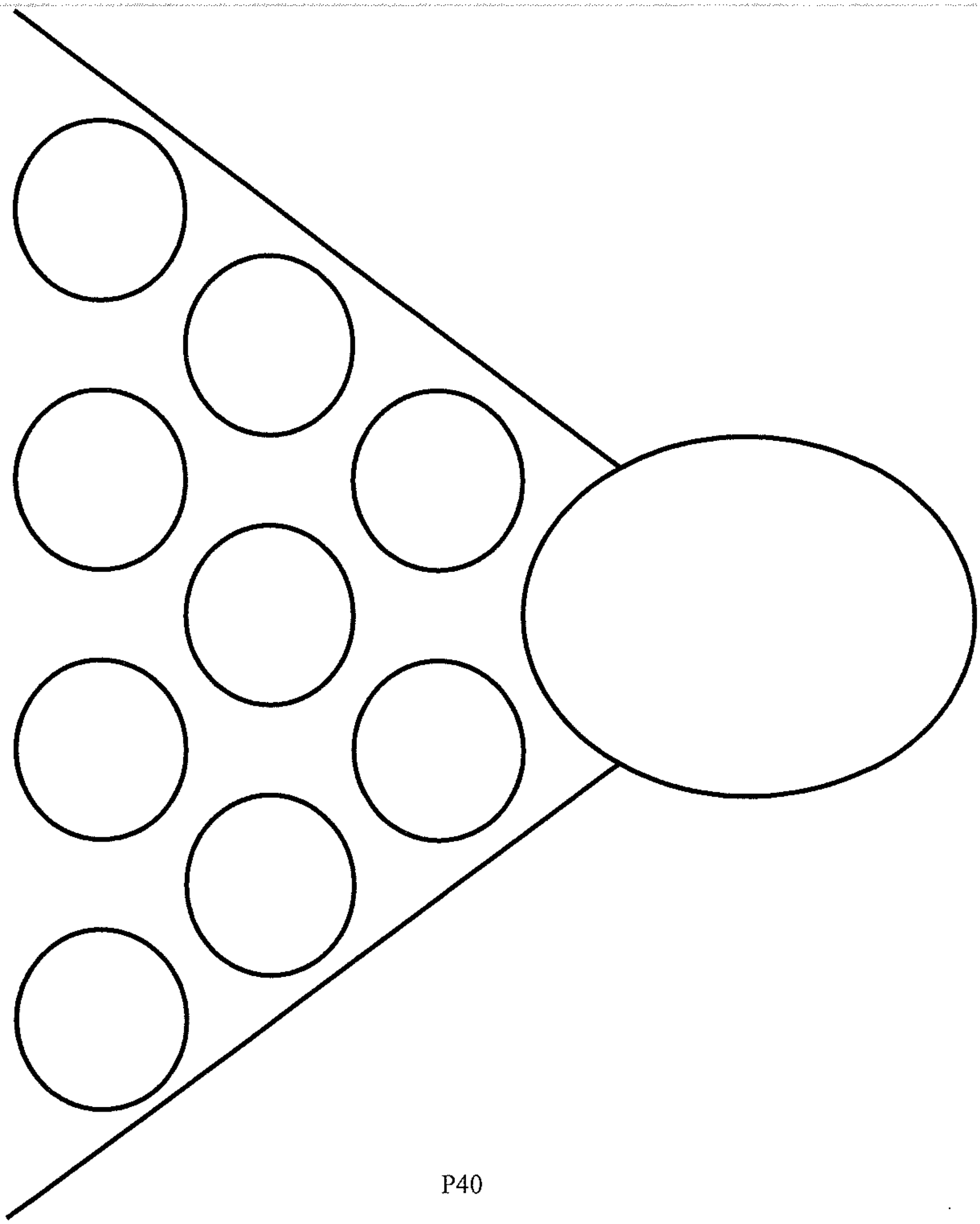

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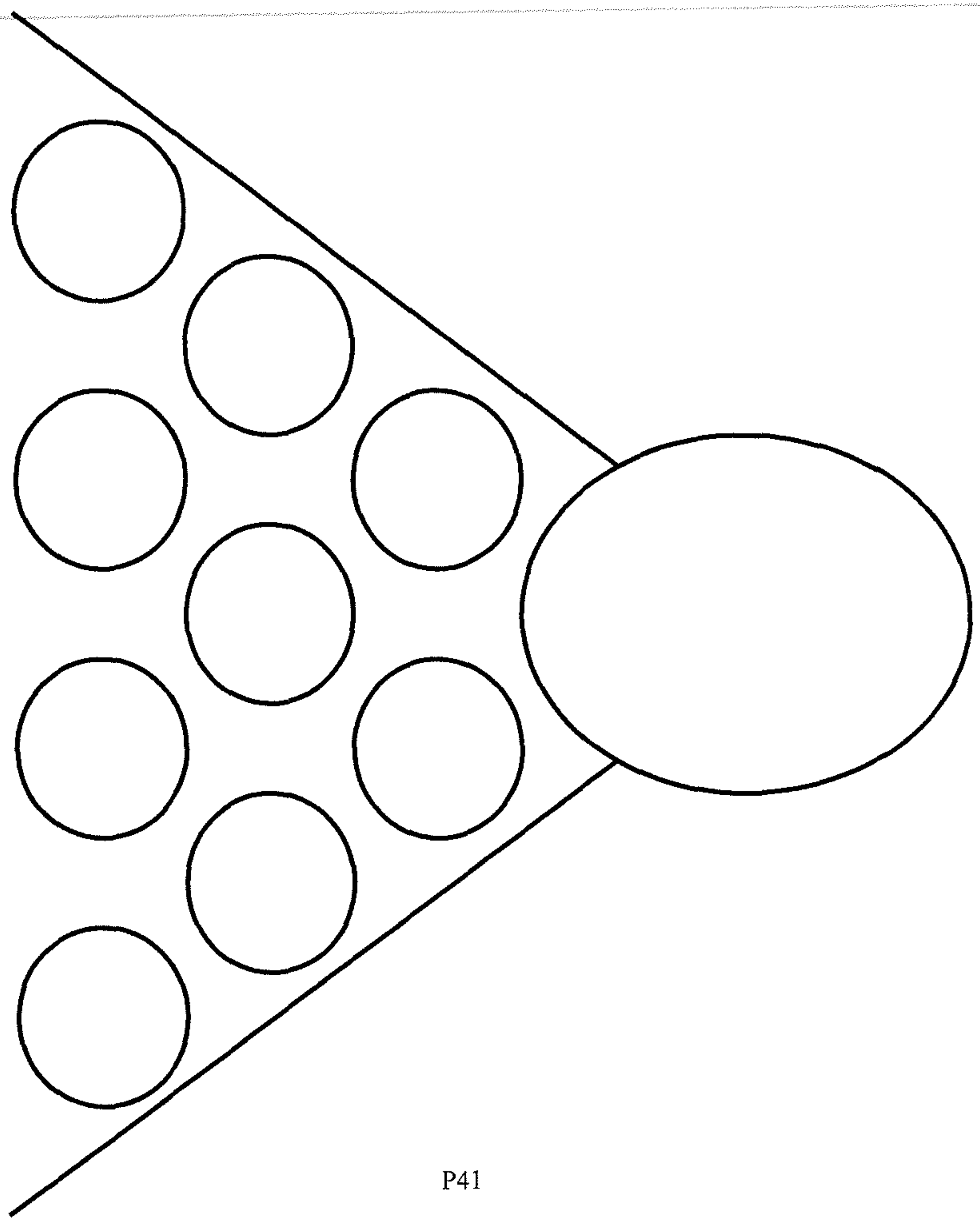

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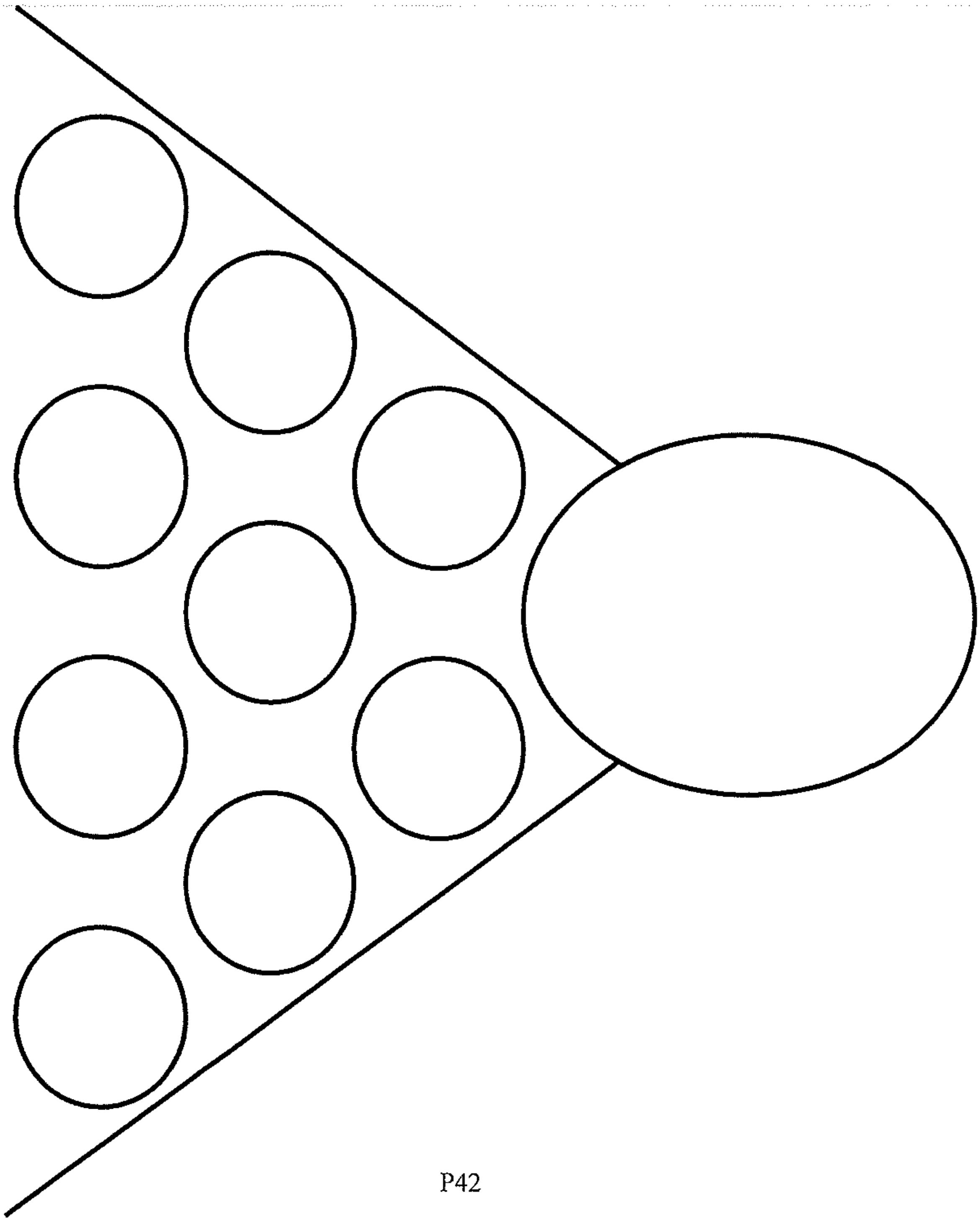

River Systems Vocabulary

To get you acquainted with the River Systems Unit, browse through this packet underlining and highlighting unfamiliar words, phrases and ideas. Once you have looked through this packet, choose 15 words, phrases or ideas you feel will be important for you to know and be able to define during our River Systems Unit. Complete all fields of the table below: words, definitions, and pictures.

Word	*Definition*	*Picture*

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River Vocabulary

1. **Bank**: To border or protect with a ridge or embankment
2. **Basin**: An artificially enclosed area of a river or harbor designed so that the water level remains unaffected by tidal changes. A small enclosed or partly enclosed body of water.
3. **Bluff**: A steep headland, promontory, riverbank, or cliff.
4. **Breakwater**: A barrier that protects a harbor or shore from the full impact of waves.
5. **Channel**: The deeper part of a river, harbor, strait, etc., where the main current flows, or which affords the best and safest passage for vessels.
6. **Current**: A steady, smooth onward movement
7. **Dam**: A barrier constructed across a waterway to control the flow or raise the level of water.
8. **Delta**: A similar deposit at the mouth of a tidal inlet, caused by tidal currents.
9. **Erosion**: The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface.
10. **Flood control**: engineering) act or technique of trying to control rivers with dams etc to minimize occurrence of floods
11. **Flood Plain:** A plain bordering a river and subject to flooding.
12. **Levee**: An embankment raised to prevent a river from overflowing
13. **Lock**: A section of a waterway, such as a canal, closed off with gates, in which vessels in transit are raised or lowered by raising or lowering the water level of that section
14. **Marsh**: An area of soft, wet, low-lying land, characterized by grassy vegetation and often forming a transition zone between water and land.
15. **Meander**: Circuitous windings or sinuosity's, as of a stream or path.

River Vocabulary

16. **Melt water**: Water that comes from melting snow or ice.
17. **Oxbow**: A U-shaped bend in a river.
18. **Reservoir**: A natural or artificial pond or lake used for the storage and regulation of water.
19. **Riparian Zone:** An area including the trees and plants that live and grow near water on the banks of stream, rivers, and lakes. Riparian zones reduce flooding, improves the quality of water, stores water and provides cover and shade for animal life.
20. **Sandbar**: A ridge of sand formed in a river or along a shore by the action of waves or currents.
21. **Sediment**: Solid fragments of inorganic or organic material that come from the weathering of rock and are carried and deposited by wind, water, or ice.
22. **Silt**: A sedimentary material consisting of very fine particles intermediate in size between sand and clay.
23. **Slough**: depression or HOLLOW usually filled with deep mud or mire. also slue A stagnant swamp, marsh, bog, or pond, especially as part of a bayou, inlet, or backwater.
24. **Spillway**: A channel for an overflow of water, as from a reservoir
25. **Spit**: A narrow point of land extending into a body of water
26. **Watershed**: The region draining into a river, river system, or other body of water.

Watershed Definition

A river system is influenced greatly by its surrounding land area. To fully understand streams and rivers, we must first learn about the surrounding land area—the "watershed."

A watershed is an area that drains to a common waterway, such as a stream, lake, estuary, wetland, or even the ocean -- A watershed is a geographical feature on the landscape where rain, snow and other precipitation collects and then drains to a common water body (like a stream, bay, wetland) and / or sinks into the earth to become ground water. We all live in a watershed, and our individual actions can directly affect it. Watersheds come in all shapes and sizes. They cross county, state, and national boundaries. No matter where you are, you're in a watershed!

John Wesley Powell, scientist geographer, put it best when he said that a watershed is:

> "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community"

Produced by Lane Council of Governments

There are three phases of a watershed:

Upper River Reach: Mountain Headwaters: swiftly flowing, cold, clear water. Fish thrive in this environment because of the high dissolved oxygen content.

Middle River Reach: broad valleys, lower dissolved oxygen content, warmer water

Lower River Reach water moves from the mouth of the river to the sea—the river may also split in marshes and deltas while trying to flow to the sea.

Interactive Watersheds

Go to http://www.watershed.interactive-environment.com/main/about.php to find out more about watersheds. When you get to this site, click the numbers on the screen to preview the section. View and define each of the 13 sections.

1. ABOUT WATERSHEDS

2. PLANTS AND ANIMALS

3. WATER CYCLE

4. WEATHER AND THE WATERSHED

5. URBANIZATION

6. LAWNS AND GARDENS

7. FORESTS

Interactive Watersheds

Go to http://www.watershed.interactive-environment.com/main/about.php to find out more about watersheds. When you get to this site, click the numbers on the screen to preview the section. View and define each of the 13 sections.

8. WETLANDS

9. COASTAL ZONES

10. FLOODS AND DROUGHTS

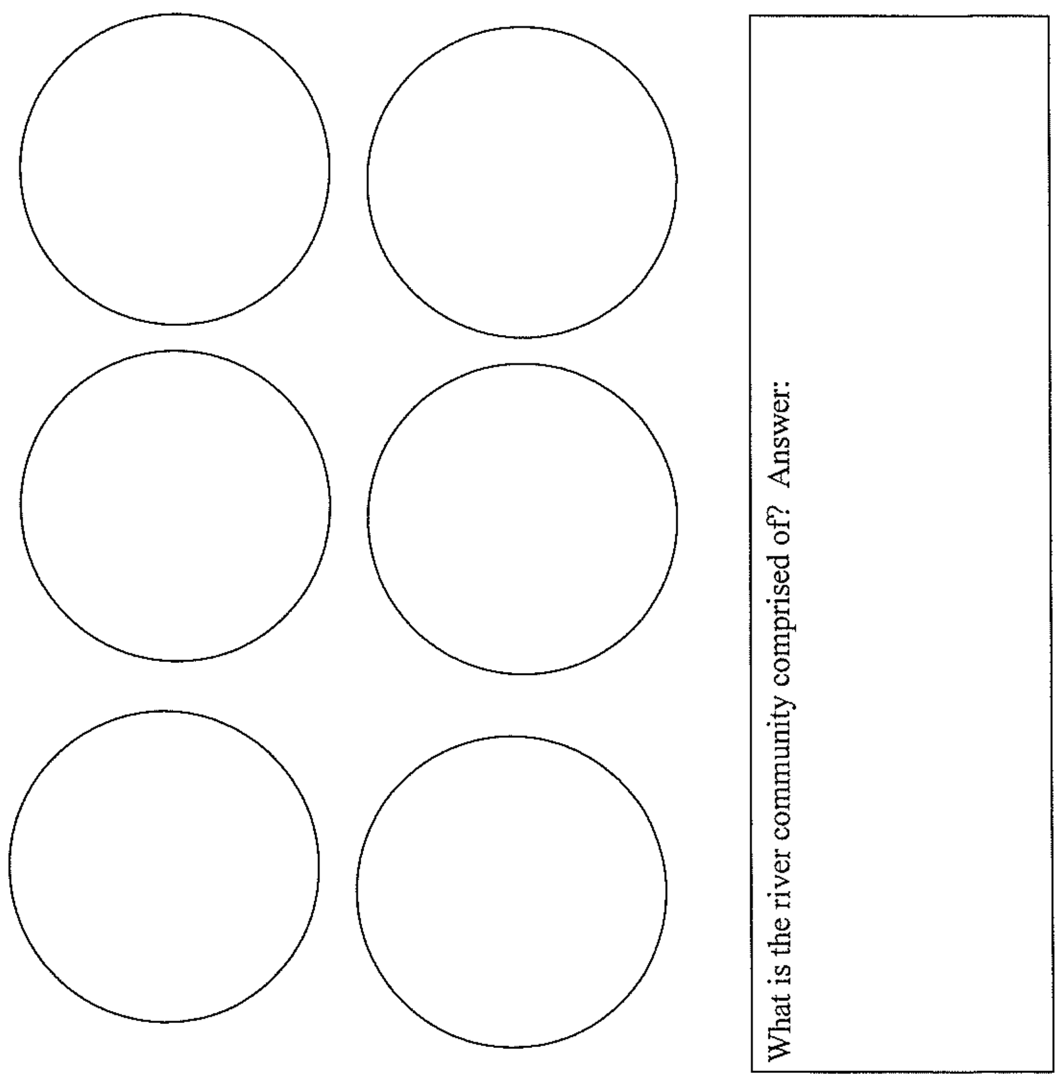
11. DRINKING WATER

12. SEASONAL CHANGE

13. FARMLANDS

Interactive Watersheds

Go to http://www.watershed.interactive-environment.com/main/about.php to find out more about watersheds. When you get to this site, click the numbers on the screen to preview the section. View and define each of the 13 sections. After you have defined each section, answer the question: What is the river community comprised of? In the finding evidence graphic organizer.



Riparian Zones

Direction: Read the information regarding riparian zones and summarize key functions of the riparian zones in the pages that follow.

Riparian Zones are an integral part of the watershed. Read and summarize the following information regarding riparian zones, its features, functions and benefits.

Riparian zones have been defined in various ways, but essentially they consist of fairly narrow strips of land bordering creeks, rivers, lakes or other bodies of water. Plant species, soil types, and topography are distinctive when compared to the surrounding land.

Although riparian areas generally occupy only a small percentage of the area of a watershed, they are crucial components of the ecosystem. A healthy riparian area: provides excellent fish and wildlife habitat; increase groundwater recharge; reduces flooding; and often increases the overall quality of the adjacent waterway.

Riparian areas include the trees and other plants that live and grow near water on the banks of streams, rivers, and lakes. May of the plants are water loving, and their roots must read standing water at a shallow depth to complete their life cycle. The typical broad leafed riparian trees lose their leaves in the fall. The vegetation under the trees is usually luxurious, with a wide variety of shrubs, grasses, and wildflowers. A healthy riparian area is evidence of wise land management.

Riparian areas benefit...

Birds: Birds find food, over, and nesting sites in riparian areas. Many birds depend on riparian areas to complete their life cycle. Rapidly growing riparian vegetation produces a multistoried habitat.

Plants: the readily available water in riparian areas encourages grasses and trees to grow rapidly. A pasture system that provides scheduled use of riparian areas by livestock can produce healthier animals as well as improved riparian conduction.

Riparian Zones

Animals: Animals come for water, food, and relief from extremes in temperature. Riparian areas often provide sheltered pathways upstream and downstream to other habitats. Beavers, otters, and other water-loving animals depend upon riparian areas for habitat. Riparian areas often provide the key resources that support biological diversity both in the riparian area and nearby uplands.

Fish: fish depend upon healthy riparian are conditions. Healthy riparian areas provide stable channels, sustained water supply; clean, cool water; food; shelter under overhanging banks; and vegetation. The overhanging vegetation is a home for insects and produces vegetative matter that provides a key food source for fish and other aquatic life in the food chain.

People: riparian areas are attractive and inviting to visitors. They offer cool shade, soothing scenery, wildlife viewing, and serene waters. Fishing and water actives are major attractions.

Riparian areas functions include...

Reduce flooding: healthy riparian areas with an abundance of trees and other vegetation slow flood waters and reduce the likelihood of downstream flooding of cities and towns. This slowing of flood waters allows some of the excess water to enter the underground water storage and reduces the height of the flood in downstream communities.

Improves water quality: when flood water overflows the banks of the stream or river, riparian vegetation slows the flood water so that it can no longer carry its load of sediment and the sediment settles out. The vegetation quickly grows through this sediment, stabilizing it with roots and covering it with plants that utilize the nutrients that out otherwise harm down stream water quality. Riparian areas also filter runoff and sediment from slopes next to the stream.

Stores water: the soils of riparian areas absorb excess water during spring snowmelt and during other flood periods. Healthy riparian areas act like a sponge and take in water readily. Often riparian areas lie over geologic faulty zones. These fractures in the rock provide pathways to groundwater storage areas. Water slowed by riparian areas enters the groundwater and some of it released later, increasing late summer and fall stream flow. Groundwater is vital and renewable recourse.

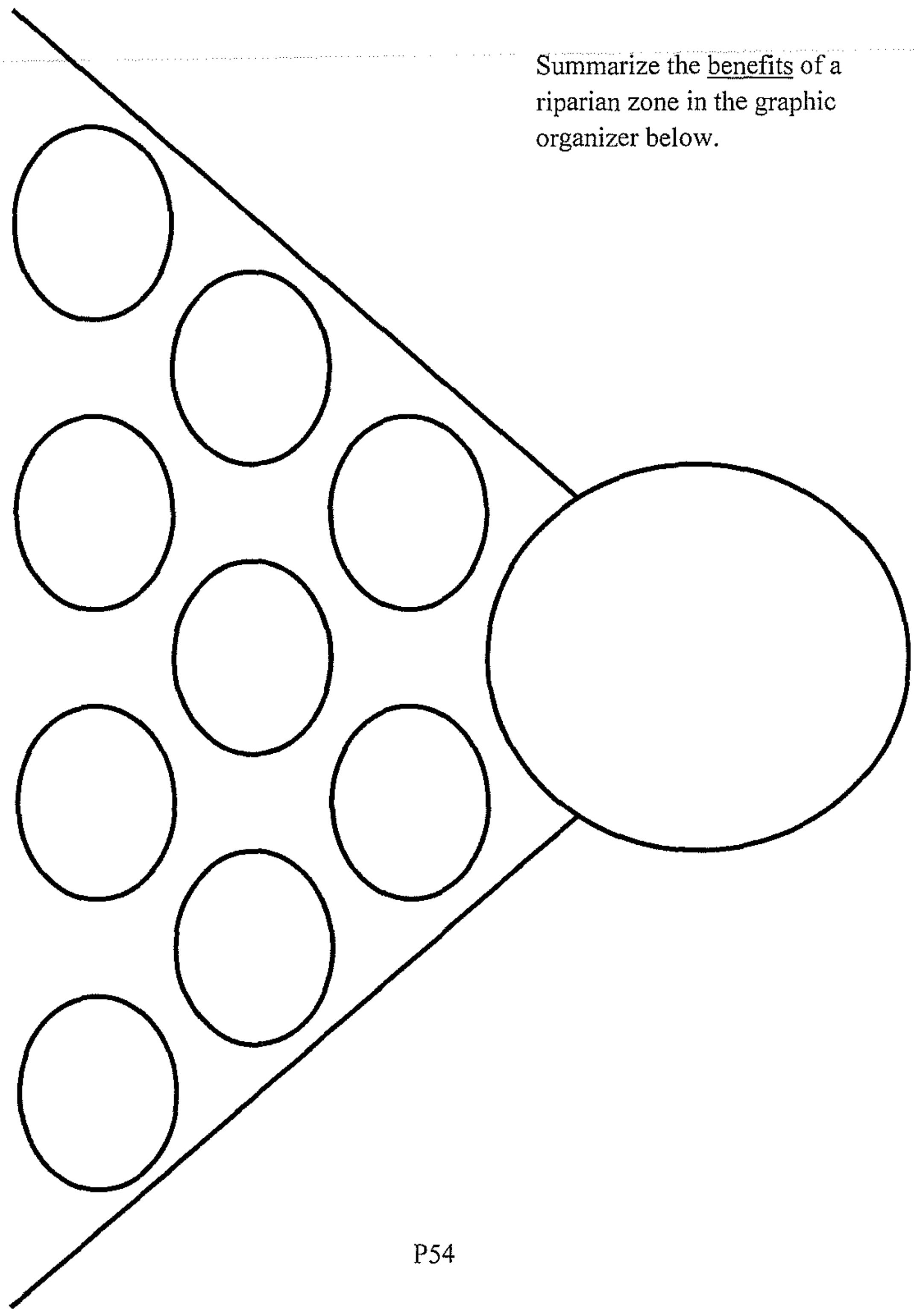
Riparian Zones

Cover and shade: Riparian areas produce and abundance of over and shade. The shade keeps water temperatures cool for fish and water-living animals. The vegetation cover provides shelter, food, and temperature relative form many birds and other animals.

Define what a riparian zone is, what a riparian does, and how a riparian zone functions in your own words.

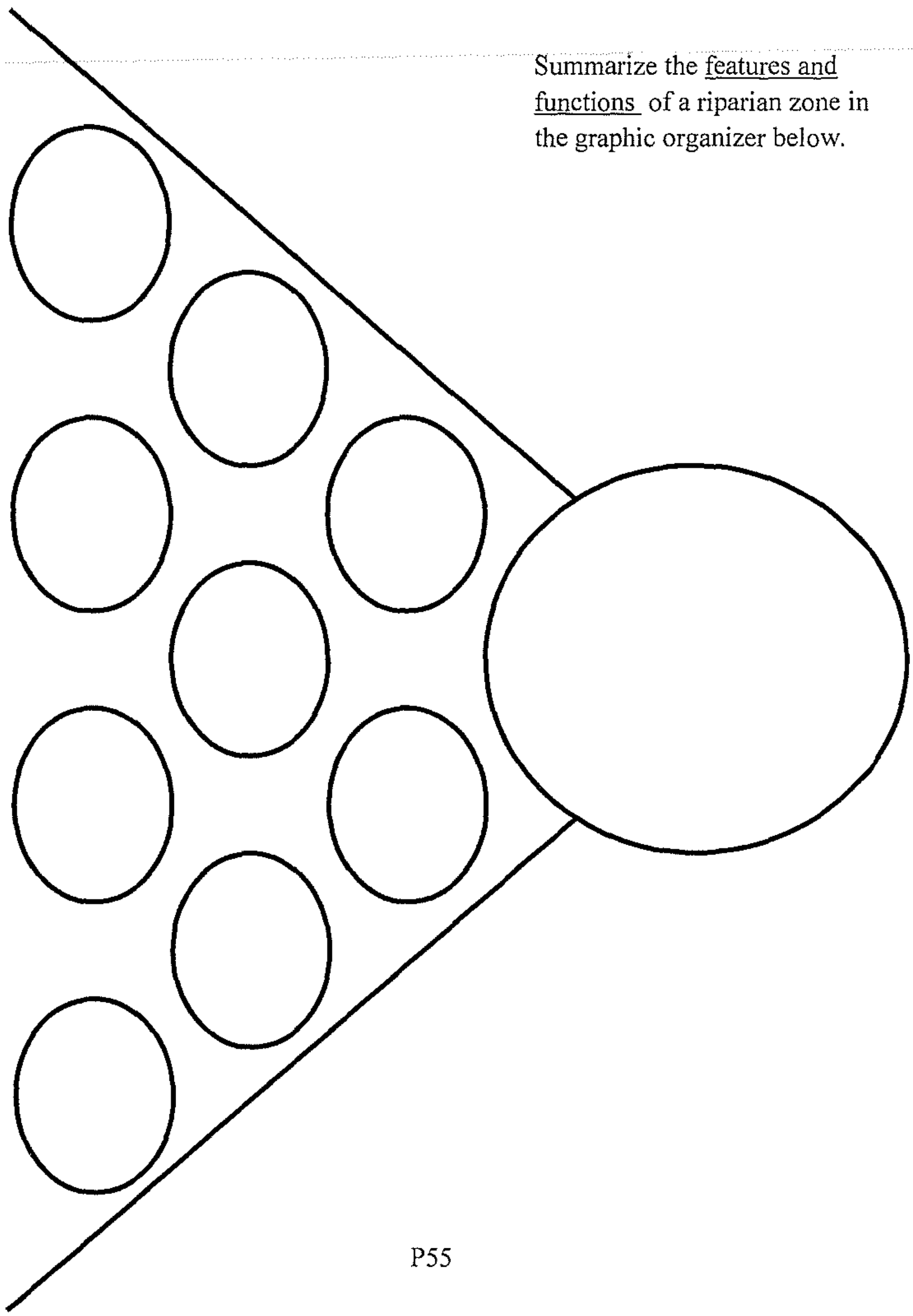
Riparian Zone Summary

Summarize the benefits of a riparian zone in the graphic organizer below.



Riparian Zone Summary

Summarize the features and functions of a riparian zone in the graphic organizer below.



Riparian Zone Questions

Briefly answer each of the questions below using your packet as and informational guide.

1. What are riparian areas?

2. What do riparian areas do? Explain.

3. How do people, animals, birds, fish and plants benefit from a healthy riparian zone?

4. Describe the riparian area around the Cedar River—use your prior knowledge about the river. Is it healthy? Why or why not (this is your opinion)?

5. What can people do to maintain healthy riparian zones?

6. If riparian zones are not healthy what does that mean for the biodiversity around the river? What does it mean for us?

Cedar River Watershed Facts

Watershed... the word means a parting, a shedding of waters. But a watershed is a gathering place, also. It is a place where hills and plains and people's lives are connected by falling rain and flowing water."
- King County Water and Land Resources

Cedar River Watershed facts:
From Forest to Faucet

- Melting snow and rain are gathered and stored in two reservoirs - Chester Morse Lake and the Masonry Pool created by the Masonry Dam. Built in 1914, the dam releases the water into two large 78 inch penstocks. The penstocks drop water 620 ft. to the hydroelectric power plant at Cedar Falls, the birthplace of Seattle City Light. The water is released back into the river and continues to flow for 12 more miles. When it reaches Landsburg, the water is screened and chlorinated before being sent to Lake Youngs.

- 78% of the Cedar River's annual flow continues past Landsburg down the Cedar River into Maple Valley through Lake Washington and out through the Chittenden Lock in Ballard.

- The watershed is a large area of land, bounded by wilderness and the edge of suburban Seattle. Most of the watershed is not fenced except near residential areas and the quality of the water is carefully monitored by a team of seven full-time watershed inspectors.

- supplies 66 percent of the drinking water to Seattle and surrounding suburban communities (1.3 million people)

- Cedar River Watershed is 141 square miles in size.

- ranges in elevation from 538 feet at Landsburg to 5447 feet at Meadow Mountain.

- receives 57 inches of rain and snow yearly at lower elevations, 140 inches at higher reaches.

Cedar River Watershed Facts

- Access to the watershed is restricted because people can carry diseases that are most harmful to people, such as cholera and typhoid, which could contaminate the water supply.

- The Cedar River Watershed is 90,546 acres, owned by the City of Seattle, that drains the Cedar River. The watershed is carefully managed to supply clean drinking water to 1.3 million people in the greater Seattle area.

- The Cedar River Watershed is an unfiltered surface water supply which produces some of the best water in the world.

- Erosion caused by deforestation has led to problems with animal habitat. The watershed is home to 81 species of animals and fish, with fish being the most harmed over the last century. Still, land erosion has had a noticeable effect on the deer, bird, amphibian, and other animal populations within the district.

- Only in the latter part of the twentieth century have concerted efforts been made to bolster runs of sockeye, Coho, and Chinook salmon and rainbow, cutthroat, and steelhead trout. In 1999, the City of Seattle created a 50-year watershed plan that includes a salmon hatchery, spawning channels, salmon habitats, and fish ladders to improve the fish population.

- As the twenty-first century begins, efforts are underway to restore and preserve the natural environment within the City's watershed, without affecting the delivery of potable water to hundreds of thousands of King County inhabitants. Needless to say, this delicate balance of life will continue to be fine-tuned for many years to come.

⇒ The following three pages contain a "virtual" tour of the Cedar River Watershed, including Chester Morse Lake, Masonry Dam, Landsburg Dam and Cedar River Falls. Read through the tour and discover your own backyard!

Map of the Cedar River Watershed

Cedar River Watershed History

Read the following information provided by the Seattle Public Utilities Department about the history of the Cedar River Watershed; then sequence the events leading up to the Seattle Public Utilities Department ownership of the Cedar River Watershed.

n 1907, the Chicago, Milwaukee and St. Paul Railway (Milwaukee) Company was granted right of way through the Cedar River Watershed. Many railroad workers lived at the town of Moncton on Rainy Season Lake, but the nearby community of Railroad Camp sprang up as the Milwaukee Rd was being laid. Moncton was flooded by the creation of Masonry Dam in 1915, which caused the level of Rainy Season Lake to rise, forming today's Rattlesnake Lake.

The Moncton railroad depot was renamed "Cedar Falls" in 1912. From the 1910's to 1940's, the Cedar Falls Depot supported up to 4 passenger and 8 freight trains a day. In addition to the main line connecting Seattle-Tacoma with Chicago and points east, there was also a branch line through Cedar Falls from Everett to Enumclaw.

The Milwaukee Railroad Company agreed to several restrictions in order to gain access to the watershed. Many train passengers remember that the restrooms were locked during the portion of the trip that went through the watershed, in order to avoid contamination of the water supply via the normal practice of discharging waste directly on the ties and track.

The Milwaukee line discontinued passenger train service through Cedar Falls in 1962. AMTRAK ran passenger trains on the Milwaukee right of way until 1977.

Logging Operations

In 1899, when the City began to take ownership of the watershed, nearly 3000 acres of timber had already been removed near Landsburg. Logging operations were still active, and several sawmills operated nearby. Before logging, most of the lower vegetation was old growth forest consisting of Douglas Fir and a small amount of spruce and cedar.

Cedar River Watershed History

Evidence exists that a large fire swept through higher elevations (above 1600 feet) between the years 1650 and 1675. This destroyed almost all of the upper timber then standing, except for about 2000 acres along the Rex River. By 1900, the upper forest was a little over 250 years old and consisted of fir and hemlock, with a small amount of cedar, spruce, and fir.

Forestation and Regulation

Between 1900 and 1924, little care was given to the watershed's forest. Timber removal denuded the hillsides. Nearly 30,000 acres of forest were removed, most of it haphazardly, leading to fire hazards and destruction of second-growth potential. Prior to 1924, attempts at reforestation occurred, but frequent fires, spread in part due to careless logging operations, destroyed almost all replanting's. Also, most logging camps and sawmills within the watershed had atrocious sanitary conditions, which added to the environmental destruction.

In 1924, the City hired Dean Winkenwerder of the University of Washington College of Forestry to come up with a plan relating to the removal and replanting of local timber. Following Winkenwerder's report, the City hired a forester on a permanent basis. The first forester was Allen Thompson. Logging continued, but methods of operation, sanitary conditions, and fire precautions were regulated and strengthened. Nevertheless, by the year 2000, less than 17 percent of the old growth forest remains, although a large portion of the watershed is thick with 80-year-old second-growth forest.

In 1962, landowners signed the Cedar River Watershed Cooperative Agreement, which set up a process of land transfers that resulted in Seattle's complete ownership of its watershed lands. This led to further procedures for fire protection and public access control. In 1996, the USDA Forest Service ceded its watershed land to the City, which gave Seattle final and sole ownership of the entire watershed.

http://www.cityofseattle.net/util/cedarwatershed/history.htm

Cedar River Watershed Timeline

Cedar River's history over the last century is a story of devastation and, recently, redemption. In the late 1800s, the lower reaches of the watershed were clear-cut by railroad logging. Complete development was held off only because the City of Seattle—in response to the Great Seattle Fire of 1889—began acquiring land within the watershed to create a dedicated source of water. Today, no one lives in the watershed and lush second-growth forest covers the remnants of those early days.

Extensive archaeological investigations in the late 1980s yielded artifacts verifying people had been there 9,400 years before present time, still the oldest verified human use at that elevation in the western Cascades.

1888	Seattle leaders call an election to decide if the city should own and operate its own water system.
1889	June 6: A patchwork of private water companies is unable to contain the Great Seattle Fire, which destroys the 64-acre business district in 12 hours. July 8: A vote of 1875 to 51 favors issuing bonds to build a water supply system based on the Cedar River.
1898	The first land within the watershed, site of the Landsburg intake, is acquired by the City through condemnation judgment.
1901	The first drinking water is delivered from the Cedar River to Seattle.
1925	Seattle Water's nursery grows millions of seedlings needed to replant heavily logged areas in the watershed.
1962	Landowners sign the Cedar River Watershed Cooperative Agreement, which sets up a process of land transfers that will result in Seattle's complete ownership of watershed lands, and establishes procedures for aggressive fire protection and controlling public access.
1989	Public input affirms the closed status of the watershed, and directs development of education, research, fish, wildlife, forestry, cultural resource, and recreation programs.
1996	Seattle Water and USDA Forest Service complete an historic land exchange, giving Seattle sole ownership of all lands in the watershed. The Friends of the Cedar River Watershed is incorporated.
2000	Construction of the Cedar River Watershed Education Center begins.
2001	The Cedar River Watershed Education Center is open to the public.

Virtual Tour of Moncton

When the new dam was finally finished in 1915, the city rejoiced. Now there was a steady source of clean water controlled by the city. Moncton - November 25, 1914

However, as the water rose behind the dam, in the nearby town of Moncton, people started noticing puddles appearing when there had been no rain.

And the more the water rose behind the dam, the higher the water rose in Moncton.

Moncton - May 15, 1915

Soon, people were using rowboats to get around town.

Moncton - May 15, 1915

Many of these hardy souls didn't move away, they just moved to the second floor.—Moncton - June 28, 1915

As the waters kept rising, it was discovered that the dam had been built on an area of glacial murrain (hills of sand and gravel left over from glaciers) that leaked. —Moncton - June 28, 1915

Virtual Tour of Moncton

The pressure of the water collecting behind the dam caused the area to leak and the water appeared in the streets of Moncton.

And thus, Rattlesnake Lake was born.

Moncton - July 7, 1929

When Masonry Dam was created, the town of Moncton was inadvertently flooded and soon Rattlesnake Lake was formed. This series of pictures shows the gradual destruction of the town of Moncton. Engineers did not take into account the geology on which the dam was being built upon. When the town of Moncton started to flood, engineers discovered the dam was built upon an area of glacial murrain (hills of sand and gravel left over from glaciers) that leaked. Now, when engineers build, the site upon which they intend to build is geologically assessed in order to prevent catastrophic events like those in Moncton.

Can you think of a time when people tried to "fix" something, but it turned out to cause more problems instead? What is the event or occurrence?

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In the space below, describe a situation that did not turn out as you expected because of some outside influence you did not take into account. What did you learn from this experience? For example, if you were to bake cookies and not take into account the temperature of the oven, the cookies may not turn out as you had planned. You may have learned to check the temperature of the oven before you insert the cookies, and you might also have an independent thermometer in the oven to double check the actual temperature.

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Present Day Cedar River Watershed Virtual Tour

At 5414 feet, Meadow Mountain is the highest point in the Cedar River Watershed.

At the crest of the Cascades, the headwaters of the Cedar River begin near Yakima Pass.

Most of the remaining 14,000 acres of old-growth forest in the watershed are at high elevations.

At the center of the Joe E. Monahan Research Area, Findley Lake is an undisturbed jewel nestled in the Cascade Range.

Above Chester Morse Lake, the Cedar River provides excellent spawning habitat for endangered bull trout.

A rich wetland has developed around the remnants of ancient forests where the Rex River enters Chester Morse Lake.

Cedar River Watershed Virtual Tour

The snow pack that collects in the winter is a vital source of drinking water to fill our reservoirs for the dry summer months.

Looking east across Chester Morse Lake towards the highest point in the watershed, Meadow Mountain.

Towards the end of the summer, the water level in Chester Morse Lake can drop dramatically.

Chester Morse Lake is the main storage reservoir in the watershed.

From the Masonry Dam, looking east towards the mountains of the watershed, across the Masonry Pool, one of two storage reservoirs in the watershed.

The Masonry Dam can hold back up to 16 billion gallons of clean water.

Cedar River Watershed Virtual Tour

Constructed in 1914, this relatively small dam is operated for flood control and hydroelectric power while storing water for fish, people, lakes and the locks!

One of many beautiful places in the watershed, Cedar Falls inspired the naming of the town

Rattlesnake Lake Recreation Area, managed by Seattle Public Utilities, provides opportunities for walking, biking and hiking in a spectacular natural setting.

At Landsburg, 1/3 of the annual flow of the Cedar River is diverted into pipes for drinking water. Over 100 million gallons of water a day are screened, chlorinated and fluoridated, then delivered to customers throughout the greater Seattle area.

The Landsburg Diversion Dam releases 2/3 of the annual flow of the Cedar River to provide water for Lake Washington, the Hiram M. Chittenden Locks and four species of

One of several small lakes in the watershed, Walsh Lake has a resident population of land-locked sockeye salmon (also known as kokanee).

Cedar River Watershed Virtual Tour

The clean, reliable water delivered from the Cedar River is some of the best in the world!

This view of the Cedar River is typical of low elevation areas in the watershed. In 2002, fish passage facilities at Landsburg will allow salmon to spawn in this excellent habitat for the first time in over 90 years!

As you looked through the previous pages, you saw a functioning watershed. In your own words, describe a watershed.

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"Salmon On the Brink"

Summary/Notes of Film	Key Words/Ideas

Questions you have…

Answer to "big question"

Why should humans care about salmon? What is the big deal?

Salmon on the Brink

After you have watched the video "Salmon on the Brink" answer the following questions.

Why are salmon on the "brink?" What are the factors contributing to their decline?

What are the four "H's?" What do they mean?

What does it mean that salmon are a "keystone" species?

What can you do to improve the plight of all Salmonoids?

Saving the Salmon

Using the "Saving the Salmon" article, complete the informational table depicting the key features of an unhealthy environment for salmon. In addition, you will need to use your own background knowledge and good sense to determine how these potential problems for salmon are also solutions for humans. In other words, fill the table below stating why the issues are bad for salmon and good for humans.

Issue	**Why is this issue a potential problem for salmon?**	**Why is this issue a problem or a solution for humans?**
Logging		
Golf Courses		
Dams		
Farms		
Suburbs		
City		
Industry		
Fishing		

Saving the Salmon

Now, pick one of the 8 issues and **come up with a proposal** to decrease the threat to salmon without lowering the standard of living in the community. That is, people still need to raise cattle, log certain areas, live in and out of the city, get electricity from somewhere, and make a living.

- This proposal should be a paragraph in Jane Shaffer (you know what this means) style with a\clear thesis statement.
- This is **due today, double spaced, in pen** and written legibly.
- You may write your rough draft on the rest of this paper.

Upper Cedar to Open to Fish

By Eran Karmon
Thursday, June 27, 2002, Seattle Times

Please note: Content on this page were redacted due to copyright concerns.

Upper Cedar to Open to Fish

Eran Karmon: 206-464-2155 or ekarmon@seattletimes.com.

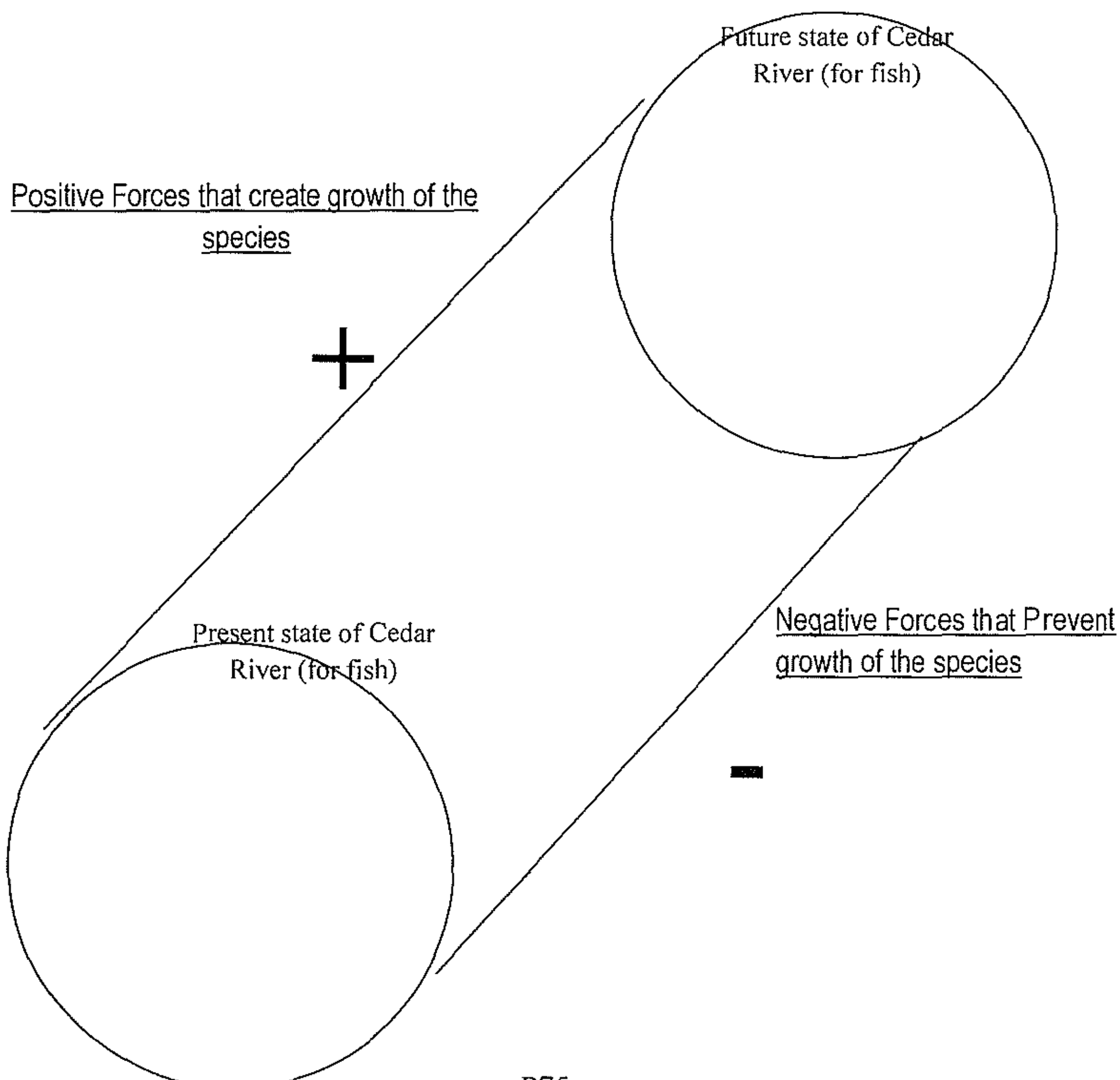
Please note: Content on this page were redacted due to copyright concerns.

Graphic Organizer

From your reading of the Cedar River opening up to fish once again, complete the bone process graphic organizer.

Bone Process

1. Brainstorm statements that identify the present state of Cedar River Salmon
2. Reverse the process and identify the future state of Cedar River Salmon.
3. Identify positive forces that create growth of the species and then negative forces that prevent growth of the species and place above and below the bone diagram.



Scientific Method

Science is best defined as a careful, disciplined, logical search for knowledge about any and all aspects of the universe, obtained by examination of the best available evidence and always subject to correction and improvement upon discovery of better evidence. What's left is magic. And it doesn't work. -- James Randi

For centuries, people based their beliefs on their interpretations of what they saw going on in the world around them without testing their ideas to determine the validity of these theories — in other words, they didn't use the scientific method to arrive at answers to their questions. Rather, their conclusions were based on untested observations.

Among these ideas, since at least the time of Aristotle (4th Century BC), people (including scientists) believed that simple living organisms could come into being by **spontaneous generation**. This was the idea that non-living *objects* can give rise to living *organisms*. It was common "knowledge" that simple organisms like worms, beetles, frogs, and salamanders could come from dust, mud, etc., and food left out, quickly "swarmed" with life. For example:

Observation: Every year in the spring, the Nile River flooded areas of Egypt along the river, leaving behind nutrient-rich mud that enabled the people to grow that year's crop of food. However, along with the muddy soil, large numbers of frogs appeared that weren't around in drier times.

"Conclusion": It was perfectly obvious to people back then that muddy soil gave rise to the frogs.

Observation: In many parts of Europe, medieval farmers stored grain in barns with thatched roofs (like Shakespeare's house). As a roof aged, it was not uncommon for it to start leaking. This could lead to spoiled or moldy grain, and of course there were lots of mice around.

"Conclusion": It was obvious to them that the mice came from the moldy grain.

Scientific Method

Observation: In the cities, there were no sewers nor garbage trucks. Sewage flowed in the gutters along the streets, and the sidewalks were raised above the streets to give people a place to walk. In the intersections, raised stepping stones were strategically placed to allow pedestrians to cross the intersection, yet were spaced such that carriage wheels could pass between them. In the morning, the contents of the chamber pots were tossed out the nearest window. When people were done eating a meal, the bones were tossed out the window, too. A chivalrous gentleman always walked closest to the street when escorting a woman, so if a horse and carriage came by and splashed up this filth, it would land on him, and not the lady's expensive silk gown. Most of these cities also had major rat problems which contributed to the spread of Bubonic Plague (Black Death) — hence the story of the Pied Piper of Hamelin, Germany.

"Conclusion": Obviously, all the sewage and garbage turned into the rats.

From these observations and conclusions came interesting recipes for different creatures, the following two examples are just a sampling of the many recipes people truly believed were accurate. Today of course, we know these recipes do not yield these animals, rather these recipes attract animals.

Recipe for bees: Kill a young bull, and bury it in an upright position so that its horns protrude from the ground. After a month, a swarm of bees will fly out of the corpse

Recipe for mice: Place a dirty shirt or some rags in an open pot or barrel containing a few grains of wheat or some wheat bran, and in 21 days, mice will appear. There will be adult males and females present, and they will be capable of mating and reproducing more mice.

Scientific Method

It took a long while to determine how is the world better investigated. One way is to just talk about it (for example Aristotle, the Greek philosopher, stated that males and females have different number of teeth, without bothering to check; he then provided long arguments as to why this is the way things ought to be). This method is unreliable: arguments cannot determine whether a statement is correct, this requires *proofs*.

A better approach is to do experiments and perform careful observations. The results of this approach are universal in the sense that they can be reproduced by any skeptic. It is from these ideas that the *scientific method* was developed. Most of science is based on this procedure for studying Nature.

The great advantage of the scientific method is that it is unprejudiced: one does not have to believe a given researcher, one can redo the experiment and determine whether his/her results are true or false. The conclusions will hold irrespective of the state of mind, or the religious persuasion, or the state of consciousness of the investigator and/or the subject of the investigation.

The steps of the Scientific Method include: observation, hypothesis, experimentation, conclusion and evaluation/reflection.

In the following space, describe how you have used the scientific method in your life to solve a problem. The problem you solved can be very simple to very complex. Identify and label each of the steps you took to solve the problem.

Scientific Method

Listed are the steps of the Scientific Method. Although there are five steps listed in this method, several steps within the scientific method are required to solve the problem. Read through the following scientific method steps.

Observation: You notice something, and wonder why it happens. You see something and wonder what causes it. You want to know how or why something works. You ask questions about what you have observed. You want to investigate. The first step is to clearly write down exactly what you have observed. Find out about what you want to investigate. Read books, magazines or ask professionals who might know in order to learn about the effect or area of study. Choose a title that describes the effect or thing you are investigating. The title should be short and summarize what the investigation will deal with. What do you want to find out? Write a statement that describes what you want to do. Use your observations and questions to write the statement.

Hypothesis: Based on your gathered information, make an educated guess about what types of things affect the system you are working with. This should be a testable, true/false statement to solve the problem. Identifying variables is necessary before you can make a hypothesis. When you think you know what variables may be involved, think about ways to change one at a time. If you change more than one at a time, you will not know what variable is causing your observation. Sometimes variables are linked and work together to cause something. At first, try to choose variables that you think act independently of each other. At this point, you are ready to translate your questions into hypothesis. *A hypothesis is a question which has been reworded into a form that can be tested by an experiment.*

Experiment: Design an experiment to test each hypothesis. Make a step-by-step list of what you will do to answer each question. This list is called an experimental procedure. For an experiment to give answers you can trust, it must have a "control." A control is an additional experimental trial or run. It is a separate experiment, done exactly like the others. The only difference is that no experimental variables are changed. A control is a neutral "reference point" for comparison that allows you to see what changing a variable does by comparing it to not changing anything. Dependable controls are sometimes very hard to develop. They can be the hardest part

Scientific Method

of a project. Without a control you cannot be sure that changing the variable causes your observations. A series of experiments that includes a control is called a "controlled experiment." Select only one thing to change in each experiment. Things that can be changed are called variables.

Guidelines for experimental procedures

- Change something that will help you answer your questions.
- The procedure must tell how you will change this one thing.
- The procedure must explain how you will measure the amount of change.
- Each experiment should have a "control" for comparison so that you can see what the change actually did.

Conclusion: Summarize what happened. This can be in the form of a table of processed numerical data, or graphs. It could also be a written statement of what occurred during experiments. Using the trends in your experimental data and your experimental observations, try to answer your original questions. Is your hypothesis correct? Now is the time to pull together what happened, and assess the experiments you did. If your hypothesis is not correct, what could be the answer to your question?

Items to include in a conclusion

- Summarize any difficulties or problems you had doing the experiment.
- Do you need to change the procedure and repeat your experiment?
- What would you do different next time?
- List other things you learned.

Reflection: No matter what happens, you will learn something. Science is not only about getting "the answer." Even if your experiments don't answer your questions, they will provide ideas that can be used to design other experiments. Knowing that something didn't work, is actually knowing quite a lot. Unsuccessful experiments are an important step in finding an answer. Scientists who study extremely complex problems can spend a lifetime and not find "the answer." Include what you have learned, what you could have done better, what you would do differently if you were to try this experiment again.

Using the Scientific Method

Use the scientific method to solve the following two problems: (1) how do you make fluffier eggs, and (2) how do you keep mice from getting inside your house? *Hint: I have already done one of your steps for you....*

Lab Write-up Method

Title: ____________________

Research/Question/Problem/Purpose: ____________________

____

Hypothesis (What do you predict will happen and why): ____________________

____

Manipulated Variable (the thing that YOU are changing) ____________________

Responsive Variable (the thing that you expect to change as a result of your independent variable) ____________________

Materials:

Procedures (How did you do the experiment) ____________________

____

____

____

____

Data (Results): use some sort of graph and/or chart ____________________

____

____

____

____

____

____

Conclusion (What happened? Was your hypothesis correct? Why did your experiment succeed or fail? What did you learn?): ____________________

____

____

Evaluation (What were the possible errors in your experiment, what changes could I make to have a more successful experiment): ____________________

____

____

____

____

Lab Write-up Rubric

First, Last Name (2pts) Date (1pt) Period (1pt)

TITLE of EXPERIMENT (1pt)

Research question/problem :word written (1pt), question/problem stated (2pt))

Hypothesis : (educated guess as to what will happen

If . . . then statement), word written (1pt), hypothesis stated (2pt))

Manipulated Variable:(the thing that YOU are changing)

(word written (1pt), manipulated variable identified (2pt))

Respondent Variable :(What changes as a result of your manipulated variable) (numbered (1pt), word written (1pt), respondent variable identified (1pt))

Materials : (be specific!) All materials listed/goes along with procedures (2pts)

Procedures ; (describe experiment in detail) (Procedures are listed in steps with numbers or letters (1pt); have at least 5 steps listed (1pt each=5pts total) 6 total points for this section

Data/ Results: (tables – records – graphs) (have recorded observations or data, and it is clear what was observed-(2pts))

Conclusion :(conclusion is detailed and in paragraph form; includes whether hypothesis was correct or not and WHY-

(5pts).

Evaluation :What could you have done differently? What would you change in a subsequent investigation and why. (3pts.)

35 Total Points

Using the Scientific Method

Use the scientific method to solve the following two problems: (1) how do you make fluffier eggs, and (2) how do you keep mice from getting inside your house? *Hint: I have already done one of your steps for you....*

River Project Description

You will be collecting and processing data describing the state of the Cedar River's health. You are ultimately trying to answer the question: *What makes a stream healthy, and how can humans influence that health?* Continuing in the groups you have been working in, you will prepare a final product that sums up all that you have learned—including a detailed answer to our essential question. The product will be in the form of a poster or display board. This assignment is due at the beginning of the period _________ depending on what day you have science. .

You will have a limited time to complete the project in class, so you will need to use your time wisely. Given that you will most likely be splitting up the assigned pieces and doing at least some of the work at home, it would be a very good idea to spend some time thinking about lay-out and form before the end of your last day of class time. If each of you goes home to finish your own part, you will want to be sure that when you put it all together all of the pieces will fit, that the fonts are the same style and size, and that your color schemes, graph styles, etc. match. It might be a good idea to do a mock-up of what the finished product will look like.

In addition to this page, you will be provided with a scoring guide that will tell you what I will be looking for when they grade your product (check the other side of this page). Additionally, I will ask you to evaluate each other on group participation. You will need to provide your own poster or tri-fold display board. Poster board can be purchased at most big super-markets. Tri-fold display boards can be purchased at art and craft stored. Below is a list of all of the pieces that must be on your finished product.

1. Text piece explaining what the river experience was all about, what you did, what you learned about, and a statement of the overall health of the Cedar River based upon the data you collected
2. Title for your poster
3. Complete WQI chart
4. Graph or chart showing Cedar River results compared to the "Scale of Goodness"
5. Graph of the Cedar River D.O., B.O.D., pH, Nitrate, Phosphate, and Temp. Change results showing the ideal values for a perfectly healthy river for comparison

Cedar River Project Description

6. Text pieces for each of the six tests explaining what each is, what causes it, and how it can be bad for the river or fish

7. Explanatory text piece about what BMI's are and how they can be used as an indicator of a river's health

8. Formula for calculating the Biotic Index along with an explanation of how the formula works

9. Table of BMI data collected at the Cedar River

10. Graph or chart showing the B.I. number compared to the "Scale of Goodness"

Cedar River Project must:

- Have an appropriate layout and appearance
- Be neatly typed or handwritten in pen
- Be visually pleasing
- Be grammatically correct
- Include all the listed components
- Be completed by the due date
- Have accurate data

River Project Scoring Guide

Below Standard: Meets Standard:

Approaching Standard: Exceeds Standard:

	Weighting Factor	Below standard	Approaching standard	Meets standard	Exceeds standard
Big picture text piece—includes details about what the group did day to day, what they learned, and statement of the rivers' health					
Title—can be seen from a far but not distracting					
WQI chart—includes raw results, q-values, multipliers, and adjusted scores for each tests. The final Index number is stated. Columns and					
Comparison chart—units are labeled, scale is accurate, comparison with the "pristine" river is clear					
Q-value graph—units labeled, scale is accurate, comparison is clear, shows actual numbers from river as compared to ideal numbers					

River Project Scoring Guide

	Weighting Factor	Below standard	Approaching	Meets standard	Exceeds standard
Test result graphs—graphs are titled, both axes and units are labels, comparison					
Biotic index-formula is written out, variables are labeled, and explained in detail					
BMI Table—includes names of BMI's, number caught, pollution tolerance values, feeding groups, order and					
Comparison chart—units are labeled, scale is accurate, comparison is clear					
Aesthetics—Project is visually appealing, well organized, good use of color and placement, very little white					
Semantics—grammatically correct, no spelling errors					

Peer Evaluation Form

Your Name: ____

Evaluated Group Member's Name:______________________________

Complete the following evaluation for each group member, including yourself. Be honest and fair to all being evaluated.

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strong Agree*
1. Attended every group meeting (both in and out of class).					
2. Contributed greatly to the construction of the report.					
3. Did his/her homework; brought data to the group as assigned.					
4. Participated in the organization of the project's content/layout.					
5. Shared his/her perspective/opinions during group discussions.					
6. Assisted in the editing/proofing/revising of the manuscript.					
7. Helped resolved group conflicts that arose.					
8. Took a leadership role in the group's interpersonal dynamics.					
9. Completed his/her fair share of the workload.					
10. Was a positive influence on the group.					

Peer Evaluation Form

Your Name: ________________________________

Evaluated Group Member's Name:________________________________

Complete the following evaluation for each group member, including yourself. Be honest and fair to all being evaluated.

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strong Agree*
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	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strong Agree*
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4. Participated in the or-ganization of the project's content/layout.					
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8. Took a leadership role in the group's interpersonal dynamics.					
9. Completed his/her fair share of the workload.					
10. Was a positive influence on the group.					

River Safety

Objectives:

- understand the potential dangers of a river
- recognize some of the equipment used for river safety
- learn techniques that can make the river environment safer

Dangers

- Rain
    - River level rises
    - Where you could walk out to last week, you can't this week
    - More debris floating down river
    - Shore is slippery
    - More volume=more velocity (law of squares apply)
        - 3 mph = 16 lbs of pressure per square inch of your legs
        - 6 mph = 67 lbs of pressure per square inch of your legs
- Strainers (fixed objects in the river that allow current to pass through
    - Once you get stuck in the strainers, you can't get out because of the pressure
    - Root ball's, log jams

Equipment

- PFD (personal floatation device)
- Waders, boots (provides warmth and comfort—you must have shoes on your feet if you are in the water).
- Throw bag
    - In case of emergency, you would throw this bag behind the person you are throwing to…up stream of them
    - The team furthest down stream will have the responsibility of having the throw bag—everyone will know how to use it.
- Brain—think! Don't put yourself in dangerous situations!

River Safety Quiz

- Complete the following Questions. You must answer 100% on of these questions accurately in order to go to the river for our field experience.

- What is our goal for traveling down to the river?

- Name two ways rivers can be dangerous.

- What is a strainer?

- Name three safety precautions you must take in order to be safe at the river.

- Describe the safest way to float down the river if you lose your balance and fall into the river.

- What is the most important safety precaution you must take at the river?

- What is the first thing you must do if you get into trouble (safety) at the river?

- Name two pieces of safety equipment you will be using at the river.

- What is a P.F.D.?

- What is a throw bag for?

Chapter Five

Summary, Conclusions and Recommendations

Summary

The purpose of this project was to design and implement an integrated science curriculum model in the Tahoma School District #409, in Maple Valley, Washington at Tahoma Junior High School. The goals for the integrated science curriculum model were to increase students' understanding of fundamental concepts in the sciences, support national and state science standards and benchmarks, and to encourage integrated teaching practices within science by empowering teachers with the tools to design an integrated curriculum tailored to their own students' needs.

The integrated science curriculum model produced as a result of this project had detailed integration procedures and activities utilized by ninth grade teachers at Tahoma Junior High School in Maple Valley, Washington.

Conclusions

Creating an integrated science program is an invaluable tool for all students. Not only do students learn about science content, but student are also able to process information using thinking skills, thinking behaviors and the scientific method. With an integrated curriculum, students are able to see the countless ways in which life interacts with itself. Integrated learning mirrors life, therefore, integrated teaching should be a study of life and the intricate connections we have with one another and with the planet through our actions and through the actions of others.

Creating an integrated curriculum focused on student learning and how teachers could improve their instructional practices and instructional materials to meet the growing needs of students in all disciplines. Teacher collaboration was a key component of creating a student based integrated science program. Teachers were able to consult with one another daily because of shared planning times and proximity of their classrooms. Teachers worked as a team to build the best curriculum for their students.

Integrating the science curriculum brings the world from fragmented and distinct disciplines to an entire community of living systems and events that occur daily and relate to students' lives. Additionally, integrating the science curriculum builds collaborative learning community for teachers, students, and administrators.

Creating and implementing the integrated science unit, a study of river systems, laid the foundation for creating more in-depth studies of the world in Maple Valley, Washington. During the River Systems unit, the chemistry, the biology and the geology of the environment each played a role in creating the river that we see every day. Additionally, students were able to see the connections between the sciences therefore more focused on the entire system rather than a particular aspect of the system. By studying the river system students were able to see ways in which they affect the system. With this knowledge students will be able to make informed decisions regarding their behavior in and around river systems.

Recommendations

This project may be adapted to fit the needs of any school at any grade level. The components of the project include the exploration of the habitat both in and out of a river system. A key component of the project is the student study of the river habitat, however, if a river or a stream is inaccessible, students are able to complete the survey virtually with data collected from state sources. The following are recommendations for creating an integrated science curriculum, and completing an in-depth study of a river system:

1. Create a school community where teachers can collaborate, such as formal in-service education and in the everyday workplace. When teachers are given the opportunity to develop materials together, to plan and to share teaching ideas with on another, teachers can reform their teaching. To create an environment where teachers are able to collaborate on a daily basis shared planning times and rooms in close proximity worked the best for Tahoma teachers.

2. Make teacher collaboration the foundation of the program. Provide opportunities for teacher sharing, modeling and additional professional development. One of the most important recommendations of this project is to provide professional development opportunities for teacher learning. Too often teachers will go a seminar or workshop, learn techniques, then go back to their school and shut their classroom door and forget what they have

learned. This is not an uncommon occurrence in any discipline, which is why time for teachers to share and model effective instruction practices and effective integrated lessons is so important. I do not think of integrated learning as a one time workshop or seminar. Integrated learning mirrors life, therefore, integrated teaching should be a study of life and the intricate connections we have with one another and with the planet through our actions and through the actions of others.

3. Within the science department, identify teacher leaders. Teacher leaders are often recognized by their peers as the official chair or head of the department. These teacher leaders should have detailed knowledge of teaching integrated science, the vision of integrated and the drive to reform for the sake of teaching. Teacher leaders were essential to creating collaborative working relationships among colleagues.
4. When establishing reform in a department, grade level or district, think systematically. Reform takes time and must occur at all levels in the district to be successful. One way to start thinking systematically is creating a science curricular framework over multiple grades to set clear expectations and guidelines for what is taught at different grade levels. A curriculum that provides students with the opportunity to expand on the knowledge they have already gained previously is not only sound educational practice, it is logical. For teachers, spiraling curriculum has its advantages in allowing teachers to

elaborate on topics students have examined prior while not repeating curriculum taught at various grade levels.

5. Curricular framework should match state and national standards. The framework for a school district is important to the educational practice of the district so students are not constantly re-learning the same information, but building on the knowledge base for a deeper understanding.
6. Teachers should be actively involved in the process of creating the framework and creating key units and lessons through professional development services. Teachers are encouraged to be a part of the framework process because they have the ability to determine what sequence information is taught. Additionally, it is advantageous for teachers to be a part of this process because they can influence the group to allow specific topics taught in specific grades and sequences.
7. Teachers should have the freedom to vary the teaching style and format in order to teach the concepts identified in the framework. Teachers must be able to have the flexibility to instruct students in the most effective way for those particular students. The teaching style therefore may change from teacher to teachers however the content and the standards students are meeting are the same. Teachers must feel the freedom to change the delivery method in their classroom while still maintaining the integrity of the curriculum framework for this process to be successful.

8. Guidelines and support materials should be included for all grade levels. If the curriculum office expects teachers to comply with the framework, materials and professional development opportunities must be provided and built into the school year. Teachers must have time to meet with other teachers to discuss needs, successes, frustrations imbedded into the science program.
9. An individual should be assigned to monitor, troubleshoot and evaluate the integrated science program to manage potential problems, and see potential solutions. This individual could take the role as a science coordinator assigned to the district to monitor the success of the program by surveying teachers and students, identifying support materials, modeling effective teaching strategies, facilitate professional development opportunities, stay abreast of current national and state standards, and advocate for the teachers at the district level.
10. Develop and implement a cognitive coaching program to encourage teachers to interact with on another with the goal of improving the planning and execution of lessons directed toward science integration. A cognitive coaching program can establish collegiality between teachers to better meet the goals of teachers, students and districts, and to create a community in which teachers encourage other teachers to observe their lessons and their lesson planning strategies.

11. Develop and implement a tuning protocol program for teachers to examine student work to determine the effectiveness of teaching strategies, student understanding, and student motivation and output. A tuning protocol would allow teachers to adapt lessons and instructional methods to create an effective lesson which meets the needs of integrated science students.

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