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ABSTRACT

This paper presents a site and project description and the conceptual framework of the Curriculum Articulation Project (CAP) and its relation to current math and science education reform initiatives. CAP is based on the notion that the teacher is the best individual to ascertain the learning needs of the urban, and often economically disadvantaged, youth. The project addresses the concerns of reform proposals in math and science by striving to articulate the current curriculum, by ranking the skills and knowledge necessary to provide science and math literacy to urban youngsters, and by integrating math and science in units that address the unique needs of city youth. An appendix includes a unit from the program entitled "The Clean Water Problem," which is a CAP project designed for grades seven and eight. (Contains 17 references.) (GLR)

Sharing the Vision:

Cur::iculum Articulation in Math and Science

K-U in an Urban School District

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Introduction

The improvement of urban schools is not a new concern, nor is the forming of a university-school district partnership a new reaction. However, the engagement of urban teachers and university faculty in the task of articulating the curriculum to meet the needs of urban youngsters represents a bold and innovative venture. Articulating and redesigning the planned curriculum (Gehrke et al., 1992) provides a new and fundamental role for urban teachers as curriculum makers (Clandinin & Connelly, 1992). Citing Ben-Peretz's (1975) conception of "curriculum potential," Clandinin and Connelly (1992) state that "curriculum materials and packages are not embodiments of things for teachers to do but reservoirs of "potential" from which teachers and students may create a variety of classroom curricula" (376). Such a conception of curriculum is in keeping with Cornbleth's (1990) definition of curriculum as contextualized social process, whereby curriculum is viewed as incorporating the interaction of teachers, students and school milieu (Cornbleth 1990).

Adapting the curriculum to meet the urban context (Cornbleth, 1990) produces students who maintain positive attitudes toward school, higher levels of self esteem and task completion, and perform at higher academic levels (Winfield, et al., 1993). Urban schools must undergo a

Case, K., Weinholtz, D. & McGivney, R. (1994). Sharing the vision: Curriculum articulation in math and science K-U in an urban school district. Paper presented to the New England Educational Research Organization.

paradigm shift, moving curriculum and instruction from the mere presentation of "facts" to the evaluating and synthesizing of student discovered data. Teachers need to employ concepts and skills from multiple subject areas, thereby providing students a coherent world view which builds upon and validates their prior knowledge base (Winfield, et al., 1993).

It has been suggested that the current urban curriculum is not only <u>not</u> relevant to the lives of the students it serves, but may actually "work against" the world view held by these same youngsters (Englert, 1993). Examining the findings of Fantini and Weinstein (1968), Englert (1993) recommends that the urban school curriculum be community based and supported. Englert (1993) contends that an urban curriculum should strive "to engage pupils in examining the social realities of the city, teach learning skills that will permit them to influence those realities, and provide occasions in which these skills can actually be applied to those realities in real-life situations" (39). Such a curriculum would be problem based, employing a strategy that uses a real world problem as an initial impetus for learning. (Bridges, 1992).

Building upon the above recommendations for urban schools and a problem based approach, the Curriculum Articulation Project (CAP) of the University of Hartford's Educational Main Street (EMS) sought to provide teachers with the time and creative space to articulate and redesign their classroom curriculum. This paper provides a site and project description, the conceptual framework of the Curriculum Articulation Project and its relationship to current math and science reform initiatves.

Site Description

Located in Hartford, Connecticut, the school district has a 92.1 percent minority population. Approximately 50 percent of these students come from non-English speaking homes and 52.8 percent are economically disadvantaged. Families identified as below poverty level comprise 33 percent and the median family income is $14, 032.

The average age of teachers in the district is 44 years old with approximately 13 years of classroom experience. The mean salary is $47,529.00 and 45 percent hold either a Masters degree or above.

Project Description

In the Fall of 1990, the University of Hartford initiated Educational Main Street (EMS) to create an urban learning community which represented three Hartford schools at the elementary, middle, and secondary levels. The major objective of EMS was and still is to minimize the barriers that exist between educational levels, inviting urban teachers to become affiliate faculty members of the University of Hartford. Under the direction of EMS, faculty representation from the College of Arts and Sciences and the

College of Education, Nursing and Health Professions came together to provide urban teachers with the time and resources to examine the scope, sequence , continuity and priority of skills within the math and science curricula, Kindergarten-University level. In the Summer of 1992, thirty math and science teachers, kindergarten through university level designed matrices which outlined not only what was currently being taught in their schools, but also included a ranking of topic areas that needed more instructional emphasis.

Utilizing this ranking, the Summer of 1993 marked the beginning of an effort to design an interdisciplinary, problem based math and science curriculum. Teachers worked to create units incorporating the following elements:

- Estimation
- Measurement
- Environment
- Visual Representation of Data
- Technology

Teachers and University facilitators labored in teacher grade level teams for one week in order to create problems and daily activities integrating both math and science concepts. Bringing teachers together as curriculum makers (Connelly and Callandinin, 1992) the planned curriculum resided in the integrated units of instruction constructed in these grade level teams. Recognizing that teachers and students continually construct and reconstruct their own classroom experience, teachers piloted the units in the Fall and Spring of 1993/94. Teachers will reconvene in the Summer of 1994 to reflect on the enacted and experienced curriculum in their classrooms.

Conceptual Framework

Curriculum articulation has not been precisely defined nor explored in the literature by curriculum theorists. It represents a relatively new field of inquiry which conceptually is aligned with Clandinin and Connelly's (1992) work on "teachers as curriculum makers."

> Learning to listen to the stories teachers tell of their practice is an important step toward creating an understanding of the teacher as curriculum maker. However, we see our task as researchers as moving beyond this step to a second: to create with teachers a story of teachers as curriculum makers. We see this task as a collaborative one in which we participate with teachers in their classrooms and together live out and construct a story of the teacher as curriculum maker and, in this endeavor, imagine the possibility of curriculum reform. Clandinin and Connelly, 1992, 386).

Curriculum articulation, as defined by the CAP project facilitators represented an attempt to provide teachers with the opportunity to talk vertically and horizontally across the math and science curriculum. The initial objective of CAP was for teachers to collectively examine the scope, sequence, and continuity of their classroom curriculum and thus establish a basis for teacher directed curriculum reform.

Teachers were asked to examine the scope of their curriculum in terms of both content, breadth and confinement, and were asked such questions as "What constitutes the math and science curriculum in your classroom? How are these subjects confined or limited? What particular skills do you cover? What skills don't you cover?" Questions of sequencing and continuity were asked of both grade level and multigrade level teams. "How are math and science skills built upon over time? How are these themes and skills revisited over time?"

The articulation of the scope, sequence and continuity of the math and science curriculum resulted in teacher designed matrices which outlined and ranked the skills taught by grade level. These matrices provided the framework upon which teachers worked to integrate the math and science curriculum during the second phase of the project which focused on with integrating the math and science curriculum.

Curriculum integration can be defined as the blending or coupling of two discrete disciplines, the purpose of which is "to bring into close relationship such elements as concepts, skills and values so that they are mutually reinforcing" (Goodlad, 1991, 330). Not a particularly new concept in the field of curriculum, Tyler (1949) stressed the horizontal relationship of curriculum experiences, stating that "the organization of curriculum experiences should be such that they help the student increasingly to get a unified view and to unify his (her) behavior in relation to the elements dealt with." Taba (1962) maintained that integration was "something that happens to an individual" and identified the curriculum problem as "that of developing ways of helping individuals in this process create a unity of knowledge" (299). As stated by Goodlad (1992) "The ultimate integration is in the learner, of course; the process is aided presumably by the way in which the curriculululm components are organized" (330). Goodlad (1992) continued asserting that curriculum integration is more easily accomplished at the elementary level, and acknowledged the time consuming nature of collaborative integration at the secondary level. Such difficulty may also be the result of the rooting of the high school curriculum in the dominant and traditional single subject pattern of organization which is predicated on a logical disciplinary structure.

Goodlad (1992) posed three examples of what may be viewed as competing designs of curriculum integration. Correlated-subject designs provide for the integration of learning experiences in two or more subject areas. Relationships between and among subject areas are built upon, with the identities of the individual subjects emphasized. The aim of the correlated subject design is to bring two or more disciplinary perspectives together in order to examine a single topic or issue. The fused curriculum attempts to blur the distinctions between the separate subjects brought. The identities of the disciplines disappear and the content from both subject areas are joined together to form a new unit of instruction. Cutting across an entire knowledge domain represents broad-field patterns of organization. Such an attempt is made to create a new construction from discrete subjects fused together to form a new identity. The fused curriculum and broad-field pattern of curriculum organization are currently not common in the K-U curriculum of schools for a myriad number of reasons which stem from structural, systemic, and preparatory constraints. Therefore, the integration of the math and science curriculum of CAP was based on a correlated-subject design.

Curriculum integration when predicated on the belief of teacher as curriculum maker (Clandinin and Connelly, 1992) and based on a correlated subject design provided a reservoir of content and activities from which teachers and students could potentially enact a variety of curriculum experiences. It was hoped that such a design would provide teachers with the tools to serve urban learners by showing students the transitions between math and science, as well as the reciprocal nature of the disciplines as they relate to problem solving.

Math and Science Reform

Currently reforms called for in math.and science (National Association for the Advancement of Science, 1993; National Council of Teachers of Mathematics, 1989; National Science Teachers' Association, 1992) strongly suggest a need to:

(1) reduce content because "less is more" (Sizer,1992);
(2) emphasize connections between traditional subjects; and
(3) de-emphasize specialized vocabulary while emphasizing thinking skills.

The American Association for the Advancement for Science (AAAS), the National Science Teacher's Association (NSTA), and the National Council for Teachers of Mathematics (NCTM) have constructed frameworks for reform which address the need to improve science and mathematics education in the United States at a time when student interest and performance in these fields is declining. In addition, the preparation of a citizenry who can address and work on solutions for serious global problems - environmental pollution, habitat destruction, unchecked population growth, disease and the potential for nuclear holocaust is of utmost importance. "The life enhancing potential of science and technology cannot be realized unless the public in general comes to understand science, mathematics and technology" (Rutherford & Ahlgren, 1990, .vii). Education for math and science literacy is essential because the future of our planet is at stake.

Traditionally, science and math education have stressed memorization of a multitude of facts or formulas. Current reform efforts recognize the importance of knowledge bases, as well as the thinking skills utilized in solving mathematical and scientific problems. The two disciplines have separate and unique ways of looking at the world, but they also share important common elements. Unfortunately, these commonalties have not been taught, thus, math and science remain separate in the minds of the students who are unable to make the essential connections between subjects. It is time for educators to help students develop active linkages by teaching in an integrated fashion. The math and science reform efforts actively call for these interactions. Specifically, the NCTM (1989) states:

> Students should have many opportunities to observe the interaction of mathematics with other school subjects and with everyday society...This integration of mathematics into contexts that give its symbols and processes practical meaning is an overarching goal of all the standards. It allows students to see how one mathematical idea can help them understand others and it illustrates the subjects' usefulness in solving problems, describing and modeling real world phenomena, and communicating complex thoughts and information in a concise and precise manner (NCTM, 1989, 84).

The alliance between mathematics and science has a long and rich history; science provides mathematics with interesting problems and mathematics provides science with "powerful tools" to use in analyzing data (Rutherford and Ahlgren, 1990). To enhance the relevance and usefulness of both mathematics and science, students need to experience genuine problems and resultant activities on a regular basis (NCTM, 1989).

With such tenets in mind, the Curriculum Articulation Project provided time and assistance to teachers to develop appropriate integrated math and science problems by incorporating the "powerful tools" of estimation, measurement, visual representation of data, and technology. The repeated use and increasing sophistication and development of these skills and concepts as a student moves throughout the grades is an important part of helping students construct knowledge.

> Science programs should utilize spaced learning, such that teachers cover fundamental science concepts over years, not weeks or days. Repeated experiences in different contexts assist students in building concepts (NSTA, 1992, 15).

Conclusion

The Curriculum Articulation Project addressed the concerns of reform proposals in math and science through the following measures:

(1) by striving to articulate the current curriculum,
(2) by ranking the skills and knowledge necessary to provide science and math literacy to urban youngsters and;
(3) by integrating math and science in units which address the unique needs of city youth.

The CAP project was built on the notion that the teacher is the best individual to ascertain the learning needs of the urban youth. The following unit provided in the appendix is a testimony to their knowledge and skill in developing a curriculum in context (Cornbleth, 1990).

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APPENDIX

SUMMER 1993
CURRICULUM ARTICULATION PROJECT

GRADES 7 & 8 B
THE CLEAN WATER PROBLEM

BY:
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The Clean Water Problem

In July 1993 Mr. Dwayne Nelson, the African Studies teacher at Weaver High School, led four Weaver students on a trip to Africa that they had received as 1st prize in the Connecticut History Day Contest. Although the trip was designed to deepen their understanding of African culture and history, the students soon found themselves faced with a major health crisis.

As they approached the outskirts of a small village in Ghana their bus vas stopped by the local authorities who told of a sudden outbreak of cholera. The officials explained that cholera could only be contained by securing a fresh water supply. Mr. Nelson and the students offered to help the village solve their water problem.

Fortunately pure spring water was located three miles away from the village. It was about 100 feet away from a road. The challenge for the students was to create a clean, efficient way to transport the water from the spring to the road. The village had a stockpile of 500 sheets of 8 1/2 by 11 galvanized steel that had been left over from an earlier Peace Corps project. Their job was to design and build a gutter or conduit out of the sheets using the only tool available, which could bend the sheets at right angles only (eliminating the possibility of a curved gutter).

Cholera

caused by ingestion of water-borne bacteria
spread through contaminated water supply
incubation period from 12 to 28 hours
severe diarrhea causes rapid dehydration leading to shock
easily treated with antibiotics and rehydration
high and rapid mortality if untreated
fluid replacement therapy reduces mortality from 60% to less than 20% (often down to 1%)
young and elderly have highest mortality
vaccination gives only limited protection for a few months
endemic to south and southeast asia - epidemics elsewhere
most likely in tropical and subtropical areas
rare in modern, industrialized societies
currently in the midst of the 7th (and longest) pandemic in world history
vibrio cholerae is a slightly curved, rod shaped bacteria about 2 μ by 0.5 μ (microns)
bacteria produces a toxin in the lower intestine which causes the severe diarrhea

Math

Day One

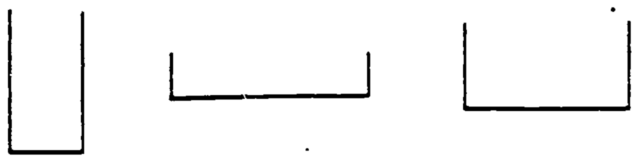
a. Explain the idea of math and science teachers getting together for a project.
b. Stress that project will "count", grades will be assigned, homework is included, etc.
c. Pass out scenario and discuss - begin to define the problem and its constraints without getting into calculations.

Day Two

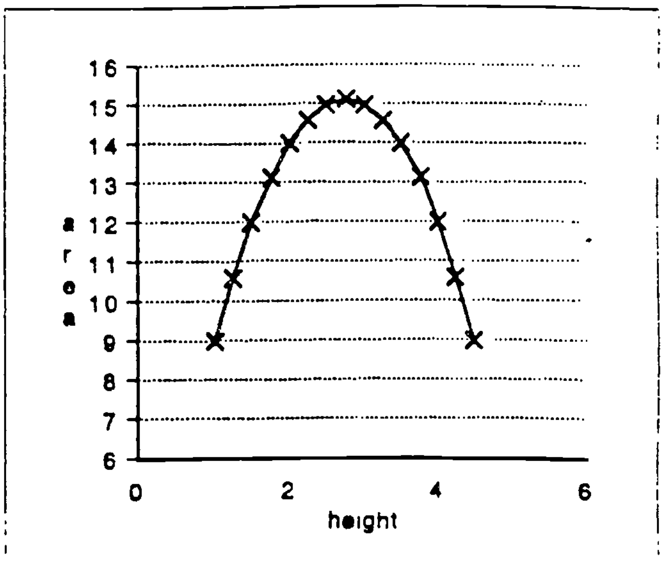
a. Elicit and list student questions regarding cholera (including questions from all disciplines - this could itself last a full period under the right circumstances) Save this list for later use.
b. Discuss the "gutter problem" in depth.
c. List and explain the constraints of the problem (if this has not already been completed) and begin to focus on how gutter can be formed.
(Note: constraints include: crimping tool makes only right angles, no curves are possible, there are only so many sheets of metal, etc.)
d. The teacher may want to divide the class into teams of 2 - 5 students who can later report on their best answer. Pass out 8 1/2" by 11" paper and get students folding paper into possible gutters. Remind students of the need to maximize the cross-sectional area of the gutter.
e. Show picture of a sample gutter (not the "best" one) and label height and base. As needed, explain how height x base = cross-sectional area.

Days Three and Four

a. Explore the connection between their first attempts and their best results.
b. Show pictures like this of team results on the board. (Drawn by teacher or students.)



c. Discuss ways of displaying this data visually. Which chart or graph would best show the data?
d. Eventually make graph of data in this form:



e. Students will include this graph in their notes.

Day Five

a. Repeat the previous day's process this time using data from different sized sheets.
b. Guide the groups toward the realization that the best gutter is always the one in which the base is twice the height (or the one in which the height is 1/4 of the width of the sheet or the one in which folding in the two heights causes the edges to just meet in the center.)

Note: At this point the math teacher will determine if it would be appropriate to conduct a review of decimal place value along with comparing & ordering decimals.

Day Six

a. Discuss very small numbers. Give examples of very small numbers. (The cholera bacteria is about 2.5 microns by 0.5 microns)
b. List the metric units of length and display how they can be written.
c. Show how a very small amount can be written in several ways: parts per million ratio, fraction form of ratio, decimal, and scientific notation.

Day Seven

a. Give real life examples of small numbers. (For example the decreasing size of this series: one person out of the class, one person out of the cluster, one person out of the school, one person out of the district, one person out of the city, etc.)
b. More practice converting from one way of writing small numbers to another.

Science

Day One

a. Explain the idea of math and science teachers getting together for a project.
b. Stress that project will "count", grades will be assigned, homework is included, etc.
c. Discussion about what cholera is.
d. Transmission by food, water, and air
e. Show slides and pictures if possible.
f. Each group will receive a contaminated petri dish. A student from each group will record on a chart the number of dots in their dish every other day.

Day Two

a. Vocabulary : contamination, disinfectant, epidemic, antibiotic, vaccination, endemic, rehydration, dehydration, ingestion, diarrhea, mortality, severe, waterborne, airborne, chlorination
b. Teacher will provide resources to allow each group to define 3 or 4 of the words.
c. Class discussion to arrive at common definitions of all words.

Day Three

a. Make sure students understand meaning of the vocabulary words by class discussion and matching words with definitions given by the teacher.

Day Four

a. Discuss short and long term solutions in treating cholera.
   1. medical treatment
   2. immediate source of clean water
   3. modern sanitation and other infrastructure
b. Methods of disinfection:
   - boiling water
   - adding chlorine
c. Disadvantages of these methods:
   - energy inefficiency
   - recontamination
   - future effects of chemicals in body, genetic, etc.
d. Provide pictures about the above discussion if possible.

Day Five

a. Using newspaper articles and library resources discuss with the students other related diseases and compare them to cholera
b. Ask for immediate oral feedback to see if students understand the subject matter.

Days Six and Seven

a. Bring in samples of water from different environments (stream, pond, tap, swamp, tap water that was allowed to sit uncovered in the classroom overnight)
b. Show real pictures of possible micro organisms that they may see in some samples.
c. Study the micro organisms under the microscope.
d. Discuss the actual sizes of these micro organisms.
e. Ask for immediate feedback from students to see how much they learned about the subject.

Day Eight

a. Bring in a speaker from the Metropolitan Water District to speak to students about water treatment in Hartford and in CT.

Prepared questions to ask the speaker:

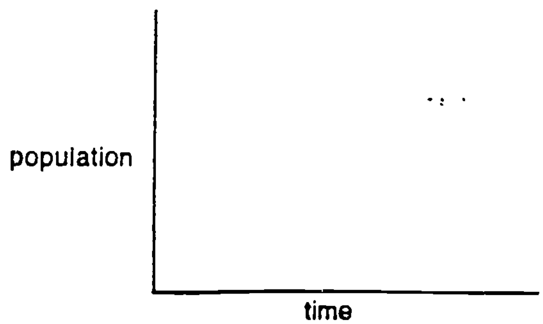
1. What skills do you need to be a water treatment technician?
2. What courses do you need to take?
3. What responsibilities do you have as a water engineer?
4. How many gallons of water are purified in an hour?
5. How many steps are there in water purification in the plant?
6. When is water most contaminated, during distribution or storage?

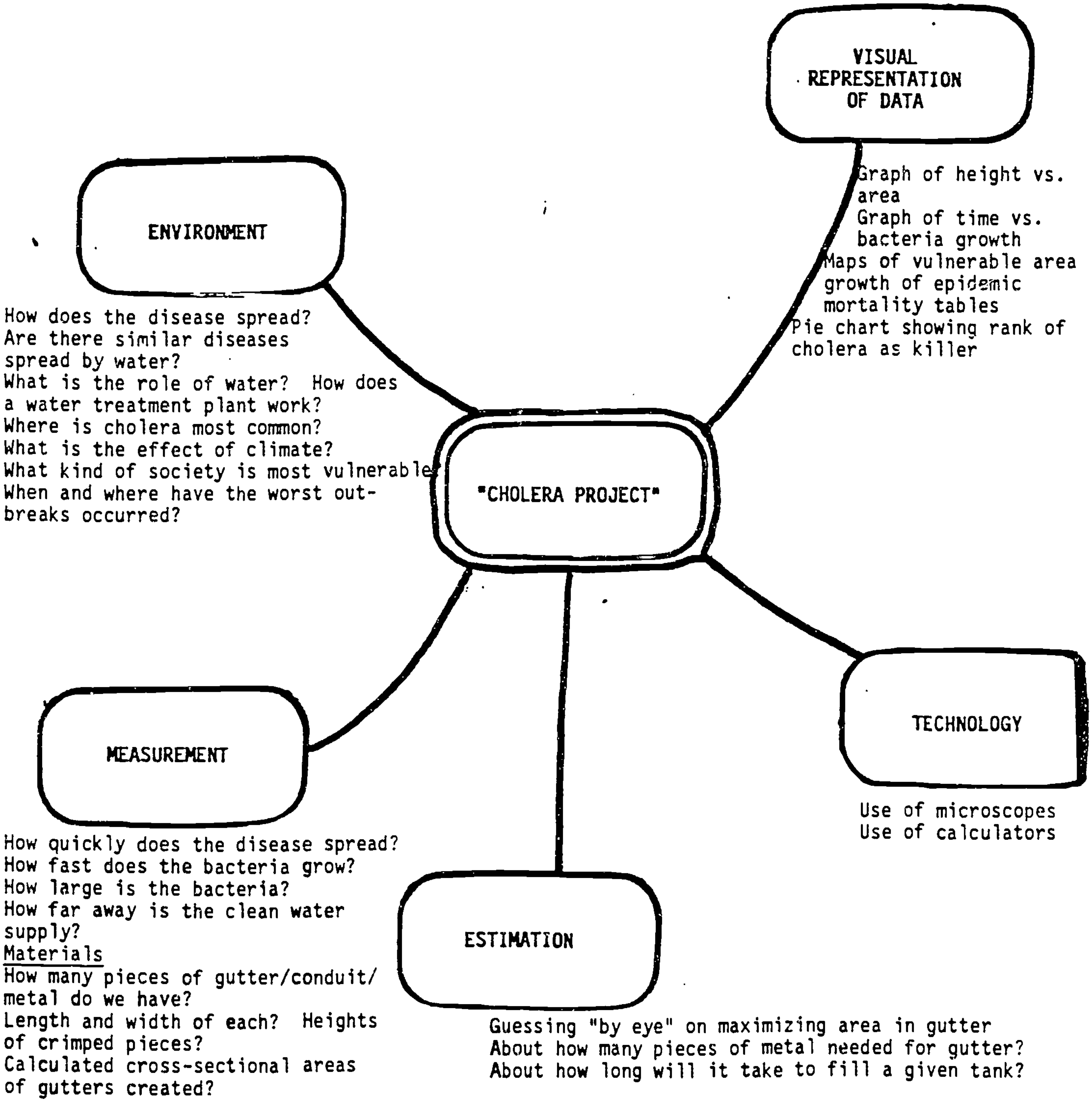
Day Nine

a. Explain how filtration works - charcoal and sand particles act as filter
b. Pour pond water through various filters (mesh, strainer, paper, charcoal, sand, etc.)
c. Observe results: Does the water look cleaner? What's in or on the filters afterwards? How long did it take for the water to go through?

Day Ten

a. Short written quiz about what students have learned about cholera so far.
b. Start discussion about colony growth in their petri dish.
c. Provide graph paper to develop a chart to explain their findings on growth rate.




VISUAL REPRESENTATION OF DATA
Graph of height vs. area
Graph of time vs. bacteria growth
Maps of vulnerable area
growth of epidemic
mortality tables
Pie chart showing rank of cholera as killer
ENVIRONMENT
How does the disease spread?
Are there similar diseases spread by water?
What is the role of water? How does a water treatment plant work?
Where is cholera most common?
What is the effect of climate?
What kind of society is most vulnerable?
When and where have the worst outbreaks occurred?
"CHOLERA PROJECT"
MEASUREMENT
How quickly does the disease spread?
How fast does the bacteria grow?
How large is the bacteria?
How far away is the clean water supply?
Materials
How many pieces of gutter/conduit/metal do we have?
Length and width of each? Heights of crimped pieces?
Calculated cross-sectional areas of gutters created?
ESTIMATION
Guessing "by eye" on maximizing area in gutter
About how many pieces of metal needed for gutter?
About how long will it take to fill a given tank?
TECHNOLOGY
Use of microscopes
Use of calculators