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ABSTRACT

Integrated Mathematics, Science, and Technology (IMaST) is a 2 year integrated mathematics, science, and technology curriculum for the middle grades. The program is composed of 10 modules that provide the full curriculum for each of these disciplines. The program is designed to be taught by a team of teachers for approximately 120 minutes per day for the full year. This document presents detailed information about the IMaST program and provides examples of lesson plans, program materials, program components, and some ideas for implementation. (ASK)

ILLINOIS STATE
UNIVERSITY

IMaST AT A GLANCE

Integrated Mathematics, Science, and Technology

The Center for Mathematics, Science, and Technology

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TABLE OF CONTENTS

ACKNOWLEDGMENTS

DIRECTORS:
Franzie Loepp, Director
Robert Fisher, Co-Director
Sherry Meier, Co-Director

STAFF:
Project Coordinator:
Richard Satchwell
Curriculum Specialists:
Robert Hovde
Trevor Nadrozny
Trudy Shea
Scott Shook
Vickie Williamson
Administrative Assistant/Desktop Publisher:
Kathy Hatch
Secretary:
Jackie Mueller

SUPPORT STAFF:
Brad Christensen
Nancy Driscoll
Dennis Gallo
Shelly Jones
Sherry Sullivan
Steve Wilder

PROJECT EVALUATOR:
Phase I
Donald Beggs, Southern Illinois University-Carbondale, Carbondale, IL
Phase II
John T. Mouw, Buena Vista University, Storm Lake, IA

DESIGN TEAM: (Seventh Grade)
Lisa Albrecht, DeForest, WI
Fred Basolo, Bloomington, IL
Richard Caulfield, Indianapolis, IN
John Gray, West Lafayette, IN
Steve Murray, Farmington, MO
Brian Poelker, Manito, IL
Joan Preer, Chicago, IL
Jane Schleeter, Plainfield, IL
Betty Shaw, Flint, MI
Elvia Solis, Indianapolis, IN
Linda Tassone, Lake Bluff, IL
Carolyn Thompson, Normal, IL
Steve Thompson, Schaumburg, IL
Bill White, Racine, WI

DESIGN TEAM: (Eighth Grade)
Al Birkholz, Bloomfield Hills, MI
John Brooks, Waterford, MI
Marilyn Cannon, Kansas City, MO
Celeste Carmouche, Prairieville, LA
Scott Chandler, Lawrenceburg, IN
Maggie Janssen, Pontiac, IL
David Mork, Alexandria, MN
Amanda Reck, Decatur, IL
Pam Stanko, Glen Carbon, IL
David Rathje, Columbus, OH
Mark Lutz, Dayton, OH

ADDRESS:

The project staff is housed at the Center for Mathematics, Science, and Technology (CeMaST), directed by Dr. Robert Fisher, Professor of Science Education; Dr. Franzie Loepp, Distinguished Professor of Industrial Technology; and Dr. John Dossey, Distinguished Professor of Mathematics at Illinois State University, Normal, Illinois. Mailing Address: Illinois State University, CeMaST, Campus Box 5960, Normal, IL 61790-5960; Phone: (309)438-3089; Fax: (309)438-3592; e-mail: cemast@.ilstu.edu; www.ilstu.edu/depts/cemast

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IMaST is a two-year integrated mathematics, science, and technology curriculum for the middle grades. The program is composed of ten modules which provide the full curriculum for each of these disciplines. The program is designed to be taught by a team of teachers for approximately 120 minutes per day for the full year.

The IMaST (Integrated Mathematics, Science, and Technology) program:

- integrates mathematics, science, and technology into a coherent theme-based curriculum;
- promotes experientially based, hands-on learning for students set in a learning cycle;
- promotes teaming among teachers from three or more disciplines;
- provides an opportunity for students to apply the concepts and skills to new situations using problem-solving strategies;
- utilizes authentic assessment;
- makes frequent use of student group work;
- fulfills benchmarks, national standards, and state frameworks in mathematics, science, and technology;
- connects to other disciplines, such as social studies and language arts; and
- responds to the latest research in teaching/learning as well as to systemic reform initiatives.

SEVENTH GRADE

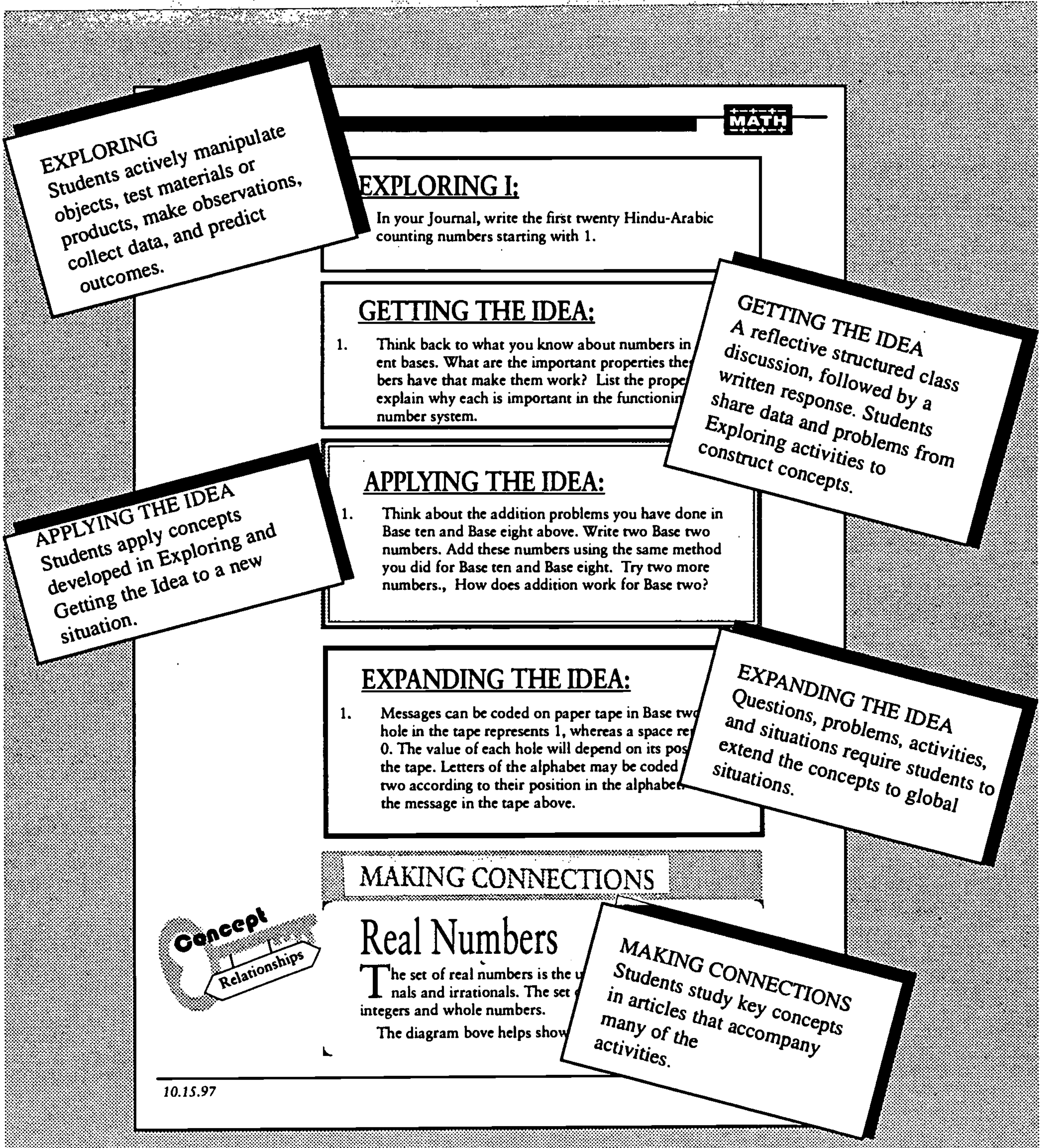
Module	Module Objective	Key Concepts	Activity Objectives
	Students will be able to:		See Page #
Wellness	◦ Apply problem-solving skills to make informed decisions concerning nutrition, exercise, and communicable disease that impact one's life and promote wellness.	nutrition, exercise, and communicable disease	18
Food Production	• Use a problem-solving process to make informed decisions concerning the appropriate use of materials and technology to produce food.	select, prepare, nurture, propagate, harvest	18
Waste Management	• Make informed decisions that will promote active involvement in reducing, reusing, recycling, and rethinking the ways of utilizing solid waste.	reduce, reuse, recycle, and rethink	19
Energy Transformations	• Cooperatively create and present a model representing energy transformations linking wellness, food production, and waste management.	harness, transform, store, distribute, use, and control	19
Manufacturing	• Design, produce, and evaluate a product that meets a need, demonstrates effective use of materials, generates little waste, and is affordable.	quality, efficiency, design, production, and materials	20
Forecasting	• Develop, graph, and solve linear equations verbally, tabularly, graphically, and symbolically in order to make predictions.	patterns, slope, and predictions	21

EIGHTH GRADE

Module	Module Objective	Key Concepts	Activity Objectives
	Students will be able to:		See Page #
Animal Habitats	• Plan a balanced ecosystem that considers the impact of and relationship between the physical environment and the behavior of animals.	population, behavior, ecosystems, measurement	22
Human Settlements	• Design a sustainable human settlement that considers the impact of and the relationship among the built environment, human behavior, and the natural environment.	design, community, sustainability	23
Systems	• Make decisions about a system based on an analysis of its function and the internal and external relationships among its characteristics (input, process, output, feedback) and boundaries.	input, process, output, and feedback	24
Communication Pathways	• Design an efficient communication system using objects, electrical current and/or sound, light, electromagnetic waves.	message, device, medium, efficiency	25

Program Materials

The program materials consist of a student edition, represented below, and a Teacher Resource Binder, pictured on pages 5 through 7. The student edition contains the instructional materials for each of the three disciplines.



The Teacher's Resource Binder includes a detailed description of how to use The Challenge to introduce the module (not shown). The student text (as shown on the preceding page) of each mathematics, science, and technology activity has a corresponding teacher text (shown below) providing answers, suggestions for discussion, and possible student outcomes for each phase of the learning cycle. Making Connections readings accompany many of the activities in the student text, and are followed by responses to issues raised within the activities.

The Teacher's Resource Binder also includes activity assessments (and accompanying rubrics outlining evaluation criteria) for each activity as well as a comprehensive integrated end-of module assessment (not shown).

MATH

I HAVE...WHO HAS?

Translation

ACTIVITY OBJECTIVE
Identify learning expectations for the activity.

ACTIVITY OBJECTIVE:

Upon completion of this activity, students will:

1. translate an English expression into an algebraic expression using a ...

INTRODUCTION
Provides background information to help teachers guide students. Indicates the duration of the activity in number of class periods.

...RODUCTION:

This activity will give students practice translating an English expression into an algebraic expression. They have been discovering patterns and recording those discoveries on graphs. Now students will have the opportunity to enhance the translation process by taking a number sentence written in the form of an English expression and translating it into an algebraic expression.

TIME

This activity should take approximately 2 class periods.

CAREER CONNECTIONS

Statistician
Engineer

EQUIPMENT/MATERIALS

EQUIPMENT/MATERIALS
Helps the teacher prepare materials for the activity.

To complete this activity, students will need:

- "I Have...Who Has" cards. The masters for the ... TE-17 and 18.

JOURNAL SHEETS TO USE WITH THIS ACTIVITY

- Exploring 13
- Getting the Idea 15
- Applying the Idea 17-20
- Expanding the Idea 21

04.15.98 *Forecasting M/TE-1*

EXPLORING
The teacher, as facilitator, circulates among the students observing, guiding, and monitoring. Possible outcomes for student exploration are noted here.

MATH

EXPLORING

STUDENT TEXT for p. M-8

1. Each class member gets one "I Have... Who Has" card.
2. Your teacher will have the first card in the series.

SUGGESTIONS FOR TEACHERS for p. M-8

1. Each class member gets one "I Have...Who Has" card. You will have to photocopy eight sets of cards for the class. Mark a circle in the upper right hand corner on one card. 2-3.

GETTING THE IDEA

GETTING THE IDEA
The teacher uses key questions to lead students to construct concepts supporting the objective.

STUDENT TEXT for p. M-8

1. What English expression was most difficult to tr
2. Write several English expressions for n + 2.

SUGGESTIONS FOR TEACHERS for p. M-8

1-2. Answers will vary. Sentences should reflect an understanding of a variable. Some time should be spent in discussing, as a class, the ideas presented by individuals or groups.

APPLYING THE IDEA

APPLYING THE IDEA
Teaching techniques include experimenting with new variables, writing reports, developing new designs, making projects, and reading assignments.

STUDENT TEXT for p. M-9

Use the pattern blocks to create the pattern expressed on one of your "I Have...Who Has" cards.

SUGGESTIONS FOR TEACHERS for p. M-9

1-4. Answers will vary. Students will use pattern blocks to illustrate patterns expressed on the ten "I Have...Who Has" cards they made.

04.15.98 *Forecasting M/TE-2*

MATH

EXPANDING THE IDEA

EXPANDING THE IDEA
Students connect the concepts to daily life, other disciplines, and a global context.

STUDENT TEXT for p. M-9

1. There were 60 passengers on a particular flight from Chicago to Washi... the passengers were Y class, ¼ were B class, 5% were M class, 40% were H class, ... were Q class. What were the total cash receipts for that particular flight?

SUGGESTIONS FOR TEACHERS for p. M-9

1. Students set up this as an equation: $24,240.00

CYBERSPACE CONNECTION

CYBERSPACE CONNECTION
Teacher's resource to Internet searches using key words related to each activity.

Information that relates to the common concept in this activity can be found on the ...ternet using one of the search engines such as Wewler, Infoseek, Yahook, etc. Try ...ing the search engine selecting keywords such as number systems and Base number systems.

MAKING CONNECTIONS

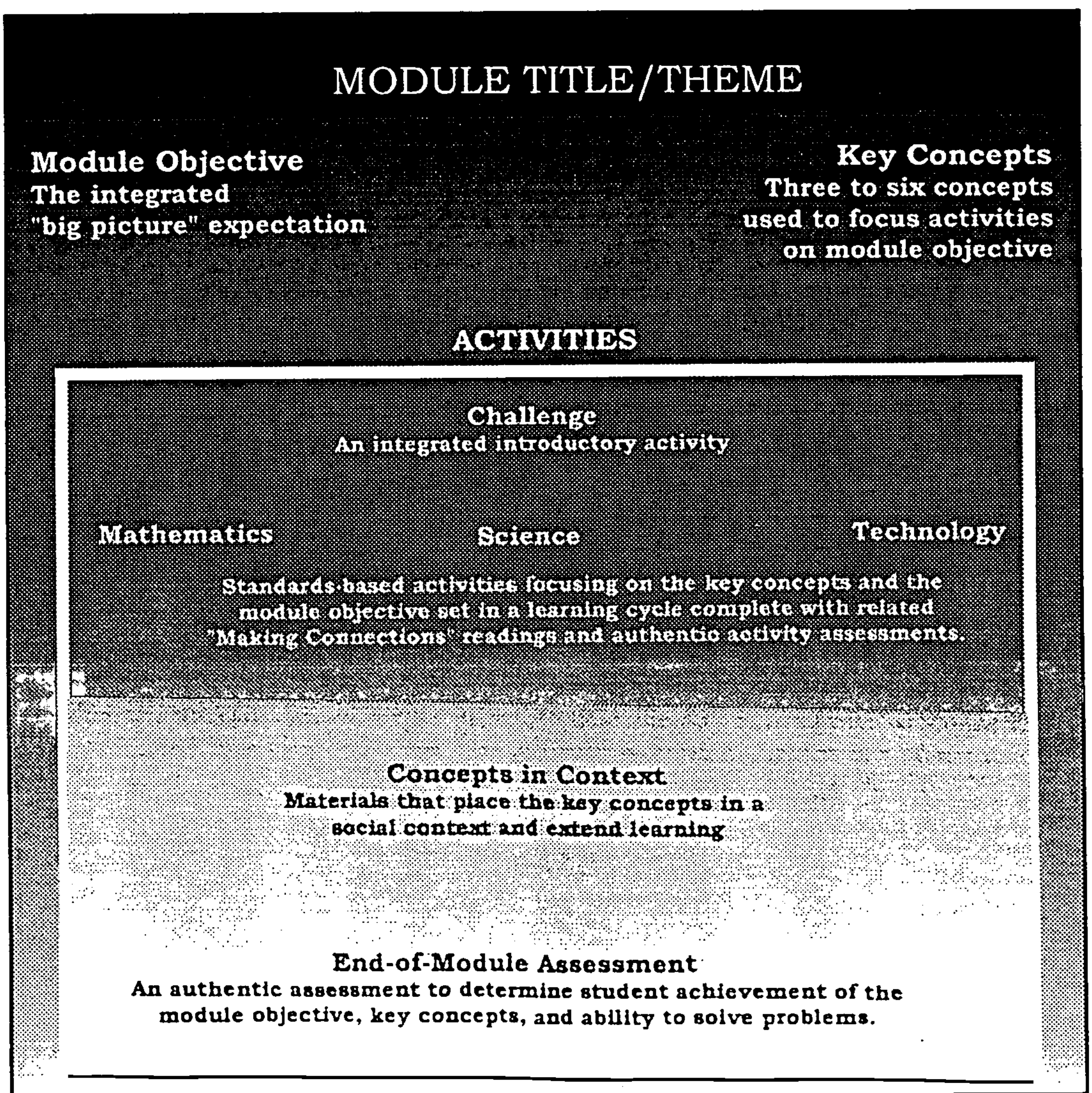
I Have...Who Has

MAKING CONNECTIONS
Questions and articles provide a rich social/cultural context for the module objective and the key concepts and opportunities for developing reading skills.

04.15.98 *Forecasting M/TE-3*

IMaST Components

The illustration below shows the main components of an IMaST module. Each module is constructed using the same framework. The title of the module reflects a theme running throughout the activities. Students begin with the Challenge, an integrated activity that introduces the module objective and the key concepts. Mathematics, science, and technology activities set in a learning cycle comprise the body of the module focusing on the module objective and key concepts. The learning cycle in the IMaST program is a four-phase instructional model: Exploring, Getting the Idea, Applying the Idea, and Expanding the Idea. The activities include Making Connections readings to provide context for the module. Activity assessments authentic to the learning experience and matched to the learning objectives are included at the end of each activity. The Concepts in Context section is an opportunity for students to extend their learning into a global setting and provides a rich context for the module activities. The End-of-Module Assessment is an integrated assessment consisting of five parts: Group Process Activity, Portfolio Assessment, DAPIC Self-Assessment, DAPIC Assessment Teacher, and the Team Growth.



IMaST Learning Cycle

During the phases of the IMaST learning cycle, students are engaged in activities that lead to internalization of concepts as they use a problem-solving process referred to as DAPIC (Define, Assess, Plan, Implement, Communicate). The learning cycle in the IMaST program is a four-phase instructional model: Exploring, Getting the Idea, Applying the Idea, and Expanding the Idea.

The teacher's and the student's roles during the various phases of the learning cycle are summarized in the table below.

	Teacher's Role	Student's Role
Exploring	• Gathers materials. • Keeps students on task. • Provides safety and skill instruction. • Asks questions. • Monitors and facilitates. • Promotes Journal writing as needed.	• Interacts with materials. • Designs and tries. • Collects and records data. • Makes predictions.
Getting the Idea	• Leads class discussion. • Questions students. • Corrects misconceptions. • Supplies terms. • Builds class data sets.	• Compares data. • Asks questions. • Forms generalizations. • Writes in Journal.
Applying the Idea	• Supplies materials. • Assures safe practice. • Keeps students on task. • Corrects lingering misconceptions.	• Applies concept, principle, or law. • Makes projects. • Conducts experiments.
Expanding the Idea	• Makes sure resources are available. • Asks questions to help students make corrections with broader contexts.	• Expands concept to more general or global situations through reading, research, and Journal writing.

Making Connections

Each IMaST module has a component called *Making Connections*. In keeping with the philosophy of allowing students to construct their own knowledge through "activity first," these readings are placed at the end of the activity. The Making Connections readings help students to expand and link what they are learning. The IMaST program emphasizes connections among mathematics, science, and technology; however, connections to other disciplines, such as social studies and language arts, are often made.

Concepts in Context

After students have completed the activities in mathematics, science, and technology, they encounter a section titled, *Concepts in Context*. After exploring the module's key concepts for a number of weeks and after gaining some insight into their meaning, the Concepts in Context section helps students *connect* what they are learning to a broader social and environmental context.

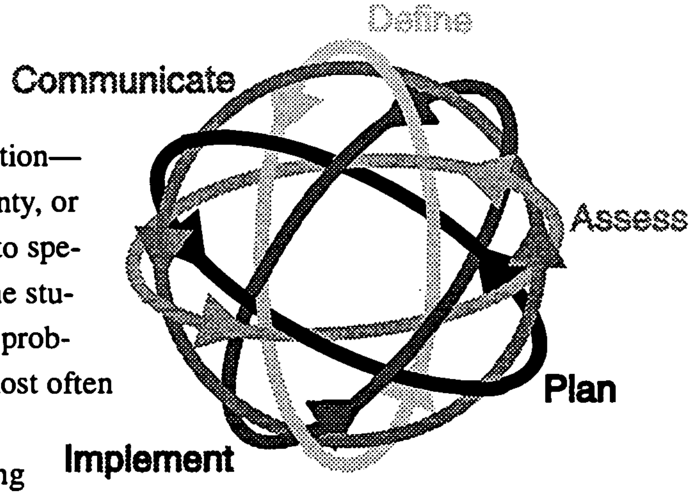
Concepts in Context is not a summary of the mathematics, science, or technology activities nor does it necessarily have a direct connection to a particular activity. Instead, this section provides a *broad context* for the module theme. While reading Concepts in Context, students may also explore relevant *processes* and the *impact* that humans have on the Earth. Given its role in contextualizing and expanding ideas, Concepts in Context is not an optional part of IMaST but is a program expectation.

The Making Connections and Concepts in Context sections can be completed in class, assigned as homework, or done as a combination of the two. If assigned in class, the materials can be processed individually or in groups. If processed individually, teachers can have one or more students report what they have learned to the class. If processed in groups, teachers can have groups report what they have learned, serve on panels, debate issues that arise from the reading, or describe an artistic representation that the group has created that relates to the material. Teachers can guide students in their reading and study with questions that help them understand the material, see connections among the three disciplines, or expand their understanding into new areas.

DAPIC and Problem Solving

Problem solving is used as a key instructional technique throughout the IMaST program. As students work to explore and solve the situations and problems presented to them in the learning cycle activities, they develop strong critical thinking skills such as: predicting, hypothesizing, planning, controlling variables, analyzing, interpreting, and assessing. Problem solving becomes "second nature" to students in the IMaST program.

Although each discipline has its own problem-solving approach, there are strong relationships among them. Teachers are naturally more familiar with, and usually prefer, the terminology associated with their own field. On the other hand, in an integrated program such as IMaST, common problem-solving terminology leads to much less confusion among students. Therefore, a generalized description of problem solving was developed by the IMaST Project and incorporated into each of the modules. This approach is referred to by the acronym "DAPIC"— Define, Assess, Plan, Implement, and Communicate.



Define: Stating the problem clearly in a sentence or two often helps to identify the problem and may even present a possible solution. This statement— or question— identifies matters involving doubt, uncertainty, or difficulty as well as the limitations related to specific need or opportunity; it defines what the student wants or needs to know. Although the problem can be identified by the teacher, it is most often identified by the student from experience.

Assess: In this stage, conditions surrounding the problem are evaluated. Any and all information that can be used to develop a good solution is considered. Students discover the barriers or difficulties in solving the problem, identify which solutions have been tried in the past, and investigate the success or failure of prior solutions. This information may come from research, or it can be obtained through experimentation. The goal is to learn as much as possible about the problem before developing a plan.

Plan: At this stage, a number of alternative solutions to the problem are suggested and analyzed. This may mean designing an experiment in which variables are controlled in order to determine the best, or most feasible, plan. A plan for putting this solution into effect is then developed.

Implement: The plan is tested. Data are systematically collected and analyzed according to the plan; modifications to the plan are made as the need arises.

Communicate: The results are analyzed, conclusions are reached, and the results are shared with others. This may take the form of writing or giving oral reports, predicting consequences, and identifying new problems to solve.

As indicated in the graphic above, the DAPIC problem-solving process has no definite starting point or order; it is not a series of sequential steps. In fact, careful observation of successful problem solvers reveals that they often use a non-linear approach. Although some students may choose to solve problems by going through the stages in linear order, more flexibility is often required. For example, a problem may occur while assessing, while developing a plan, or while implementing a developed plan. Likewise, communication may be necessary at any stage of the problem-solving process. The DAPIC model allows for all of these variations. However, students should be encouraged to define and redefine the problem as necessary to help them prioritize their actions.

IMaST Activity Assessments

Rather than merely use a knowledge-based format to assess student learning, the IMaST program assesses student learning and understanding by evaluating how well students can apply acquired knowledge and skills in new situations. Student behavior—the things students can do, say, illustrate, or write—is viewed as evidence that learning has occurred. Concepts and skills are assessed at both the individual student and group levels through completion of assignments that reflect student ability to reason, communicate (orally, graphically, and through modeling), and solve problems. The "authentic assessment" measures the knowledge, skills, and attitudes as outlined in the activity objectives using instructional methods that are appropriate to the task and common to the "hands-on" approach.

To assess discipline-specific skills, processes, and content, the Teacher's Resource Binder includes at the end of each mathematics, science, and technology activity an activity assessment and a rubric outlining evaluation criteria. Each IMaST activity assessment is a problem-based performance measure of both content and process skills that relate to that activity's objectives. With slight modifications, these activity assessments may be used for either individual or team assessments.

MATH

Name ______________ Class ______________ Date ______________

Student Activity Assessment

PATTERNS IN COORDINATE PLANES

ACTIVITY OBJECTIVE:

1. name points on the coordinate grid using ordered pairs.

PROBLEM/TASK:

1. Draw an object on the coordinate grid and record a set of at least 10 ordered pairs representing that object.
2. Use only line segments, not curves in your drawing.
3. Use all four quadrants of the grid when drawing your object.

REQUIREMENTS TO TURN IN:

1. A coordinate grid with the object drawn to show ordered pairs.
2. A list of the ordered pairs that would enable duplication of the object.
3. A written description of the process of using ordered pairs on the coordinate grid to illustrate an object.

GRADING CRITERIA:

	4	3	2	1
COORDINATE GRID	Used all four quadrants and line segments that accurately meet points on grid to correspond with ordered pairs.	Used all four quadrants, but either used curves or points to correspond with ordered pairs which are vague.	Didn't use four quadrants with accurate ordered pairs.	Ordered pairs and drawing show no relationship.
ORDERED PAIRS	Ordered pairs are accurate for duplication of drawing.	Ordered pairs accurate, but drawing doesn't clearly show accurate points.	Errors in identifying ordered pairs as used in quadrants (positive and negative integers in error).	Ordered pairs and drawing show no relationship.
WRITTEN DESCRIPTION	Clear process of using ordered pairs to visually represent an object or drawing on the coordinate grid.	Process used is correct, but description is lacking in clarity.	Process used is incorrect and description is fragmented.	Unable to describe the relationship or ordered pairs to coordinate grid and use of ordered pairs to illustrate a drawing.

04.15.98 *Forecasting M/TE-8*

IMaST End-of-Module Assessment

IMaST assesses student learning and understanding by evaluating how well students can apply the knowledge and skills developed during the module to new situations. The assessment necessary to determine student success in an integrated curriculum is an integrated assessment. The integrated End-of-Module Assessment consists of five parts:

- Group Process Activity Assessment
- Portfolio Assessment
- DAPIC Self-Assessment (student)
- DAPIC Assessment (teacher)
- Team Growth Rubric

The *Group Process Activity Assessment*, requires two class periods to complete, incorporates content and processes from all three disciplines—mathematics, science, and technology—and focuses on the module objective. The Group Process Activity Assessment presents a problem-based scenario that requires student teams to apply DAPIC, as well as the concepts and skills they developed throughout the module's mathematics, science, and technology activities, to develop their solution.

Portfolio Assessment is an ongoing activity. One final class period should be provided for the completion of this task. During this final class period, students will write essays describing the module's key concepts in terms of the module theme. As they complete their portfolios, they should attach substantiating documents that illustrate the statements made in their essay such as journal sheets, activity assessments, or project specifications. Rubrics are provided in the Teacher's Resource Binder so that the student work for the Group Process Activity and the Portfolio Assessment can be evaluated.

The *DAPIC Self-Assessment* (for students) and *DAPIC Assessment* (for teachers) contain rubrics assessing the use of DAPIC during the Group Process Activity Assessment. Although created for the End-of-Module Assessment, these forms can also be used throughout the module, perhaps as often as after each activity. The DAPIC Self-Assessment for students gives them the opportunity to register their perception of their success in using DAPIC. The DAPIC Assessment for teacher allows teachers to compare their perceptions of student achievement.

The *Team Growth Rubric* assesses student team skills during the Group Process Assessment Activity; however, it can also be used throughout the module. The Team Growth Rubric can be modified for use as a self-assessment similar to the DAPIC Self-Assessment. Team Growth rubrics are included in the Teacher's Resource Binder.

IMPLEMENTING THE IMaST CURRICULUM

The decision to use IMaST requires careful consideration of a number of issues. Whereas the typical curriculum adoption substitutes one set of curriculum materials for another, the decision to use IMaST involves planning and group effort by teachers from more than one discipline. Implementation is likely to require some changes in other aspects of the school learning environment as well.

Answers to these frequently asked questions pertaining to IMaST implementation are discussed in this section.

- Why does IMaST recommend group work?
- What are the IMaST Journal Sheets?
- How can a team of teachers from three different disciplines work together to make IMaST work smoothly?
- Can I substitute activities from other curricula?
- What special materials and facilities are needed for IMaST?

IMaST and Group Work

Group work is often justified by the fact that, as adults, students will, in nearly every circumstance, be expected to work with others. However, a more compelling reason is the research that shows learning can be enhanced through the social process. While many of the learning activities in the IMaST curriculum are designed for students working together in teams, the organization of these teams is left to the discretion of the teacher. Some teachers prefer highly-structured teams with clearly defined roles for each member of the team. Other teachers have more success with a loosely-organized arrangement. Please note that IMaST field testing has shown that it is important to be directive in the *establishment* of the teams so that, over time, each student learns to work with everyone in the class. It is also important for teachers to remember that students will be together in at least these three classes each day; assignments should be coordinated with other teachers so that students have variety throughout the day.

The IMaST Journal

IMaST provides opportunities in mathematics, science, and technology to develop writing skills by asking students to describe predictions, observations, results, and conclusions in their Journal. In addition, reflective writing at the end of each phase of the learning cycle, or at the end of each activity, provides writing practice and gives students and teachers a look at how well objectives are met. Thus, teachers may augment modules and use them to teach basic language arts skills and concepts, as well as essential concepts in social studies.

IMaST and Teaching Teams

IMaST is intended to be used for approximately 120 minutes of total class time each day. The mathematics, science, and technology teachers who are teaching the same IMaST module are teaching the same students. Students can be scheduled in three separate periods of the day, but it is desirable to sequence class periods in order to allow activities to run consecutively.

The integration of learning occurs as students move from one discipline to the next. This requires teachers to plan the instruction to provide for integration, as well as to modify the program to accommodate the learning needs of students. It is essential that the teachers using IMaST materials work together as they facilitate student learning. For this reason, it is suggested that the teachers have a common planning period each day.

The team planning periods may initially be used to review the mathematics, science, and technology activities in the module and to decide how the activities are related and support each other. Team planning sessions are also a time to compare notes on progress so that activities are scheduled appropriately to best enhance the planned integration.

In addition to the pace of instruction, team planning includes issues such as:

- possibilities for sharing equipment and supplies
- assignment of students into teams
- scheduling of common events such as field trips, classroom management strategies, and preparing for and conducting public relations activities such as an open house for parents.

Planning ahead will greatly improve IMaST implementation. The team of teachers should anticipate the materials needed, behavior of students as they are assigned into teams, and how one discipline's activities relate to the activities going on in the other disciplines.

Supplementing the Curriculum

Each activity has been carefully written to integrate the three disciplines. Sometimes, however, a teacher in one discipline may wish to substitute a favorite activity that has worked well in the past for one of the IMaST activities. If this should occur, the matter should be discussed in depth at team-planning sessions. Care must be taken to assure that this substitution of an activity meets the objectives as specified in the module and that the teachers in the other two disciplines are in agreement. Modifications or adaptations most likely will affect the other two disciplines as well as planned integration and discipline-specific articulation of student learning.

Materials and Facilities for IMaST

IMaST activities involve students in hands-on learning. The materials and tools used in these activities are those already available in schools or can be purchased locally at a reasonable cost. IMaST does not require specialized equipment beyond what is typically found in mathematics, science, and technology education laboratories. Because of the common availability of the equipment and materials, there are no unique purchasing strategies or "kits" for IMaST.

The equipment and materials needed for each activity are listed in the Teacher's Resource Binder at the beginning of each activity. These equipment and materials lists may be reviewed in advance to make sure that sufficient supplies will be readily available for each student or team. It should be noted that the equipment and materials list often suggests simple, readily available, and economical substitutions or alternatives for some of the suggested materials. Additionally, teachers may develop their own creative substitutions.

SUCCESS OF THE PROGRAM

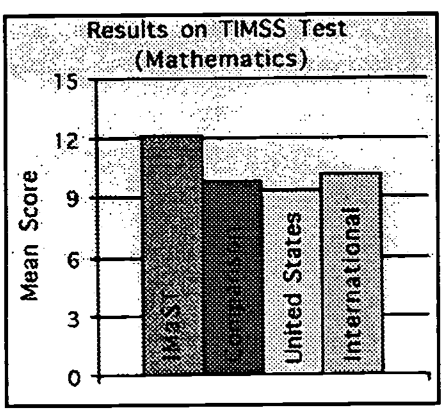
Preliminary Results

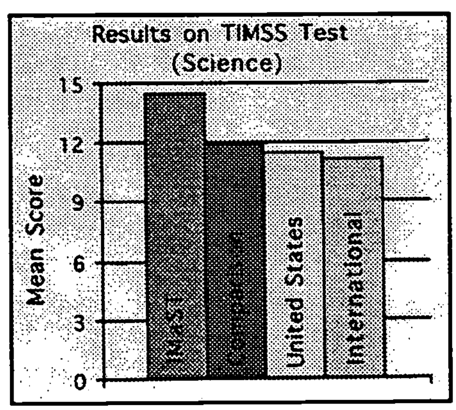
The four Bio-related Technology modules have been field tested, revised, and prepared for commercial publication. The Manufacturing and Forecasting modules have undergone field testing an additional year and have been prepared for commercial publication. The four nine-week, eighth grade modules have been piloted, are currently being field tested, and will be field tested a second time during the 1998-99 school year. Commercial publication is scheduled for the fall of 2000.

During the spring of 1997, six pilot sites from the IMaST Phase II curriculum project were administered sub-tests from the Third International Mathematics and Science Study (TIMSS). The sub-tests were constructed from released TIMSS items from Population Two. When these items were released, they had already been categorized by:

- mathematical or science concept areas,
- level of reasoning or type of thinking needed for solution, and
- rated by international difficulty level.

The items selected for use in each sub-test were selected to measure higher-order thinking skills in mathematics and science and to cover a full spectrum of content based on the TIMSS categorization.





The mathematics items were spread equally across a range of topics or concept areas including:

- number sense and fractions,
- geometry,
- algebra,
- data,
- probability and statistics,
- measurement, and
- proportional reasoning.

20

Two of the mathematics questions were classified as using simple routines or procedures, six represented use of complex procedures, and the remaining 14 items involved solving problems. The science items were spread equally across a range of topics or concept areas such as earth science, life science, physics, chemistry, and environment and the nature of science. One of these problems required the use of routine procedures and processes, and four required the use of simple information. Of the remaining 21 items, seven were classified as using complex information, four were classified as investigating the real world, and ten were classified as requiring analysis and problem solving. In order not to introduce bias toward IMaST, items were selected that did not directly relate to the thematic modules that IMaST presents. For example, if an item for life science dealt too closely with animal habitats, it was removed as a candidate from the pool. Additionally, items selected generally had a relatively high difficulty rating on the TIMSS test.

As a result of this selection process, the expected international score on the mathematics sub-test would be 10.1 and the expected U.S. score would be slightly less at about 9.4 (since U.S. eighth graders' average score was below the international average). The IMaST students scored 12.1 and the control group 9.8. The control group performed slightly above the expected level.

The expected international score on the science sub-test would be 11.1, and the expected U.S. score would be slightly higher at 11.5 (since U.S. eighth graders' average score was slightly above the international average). IMaST students scored 14.5, and the control group scored 11.9. Again, the control group scored as expected, but the experimental group scored much higher.

We are pleased with the overall performance of the IMaST group; however, we have no pre-test scores from the fall of 1996 to use as co-variants, so we can not assume these differences are due solely to IMaST participation. Several of the pilot schools are in the process of obtaining the results of state-administered tests that can be used as the co-variant.

During the current year of field testing, all sites have administered the TIMSS subtest as a pre-test, in addition to a standardized test, to their IMaST group and to a comparison group (where one exists). The sites will then administer the TIMSS tests again in the spring to the same groups of students to measure growth. This pre- and post-testing will provide us with more concrete evidence of the effect of IMaST participation on student achievement.

A more complete description of the testing process and scores is available at the project world wide web site: http://www.ilstu.edu/depts/cemast/imastwelcome.html.

APPENDIX
Activity Objectives for Seventh Grade

Module **Objective** (Students will be able to:)

WELLNESS

- Create ratios from given data.
- Use division to find the decimal equivalent of a ratio.
- Use your knowledge of joints, bones, and muscles involved in exercise to analyze situations related to movement.
- Design, build, test, and improve a prosthesis to perform a given function.
- Compare the function of a prosthesis to the function of an actual hand.
- Use a protractor for measurement.
- Develop a method for the prevention of heat exhaustion through the use of evaporation.
- Identify, gather, and organize the information needed to develop a wellness video.
- Set up a ratio and rename as a percent.
- Set up two equivalent ratios as a proportion.
- Solve problems by setting up a proportion and solve to find an unknown value.
- Determine the amount of energy per gram released during the burning of food samples.
- Produce and present a wellness video on nutrition, exercise, and communicable disease.
- Choose foods with daily nutritional requirements based on your Basic Metabolic Rate.
- Create menu plans for one day using the Food Pyramid based on the evaluation of your current average daily intake and your decisions for improvement.
- Use circle graphs to illustrate data.
- Explain how a communicable disease spreads through a population and develop a Health Behavior Plan for communicable disease prevention.

FOOD PRODUCTION

- Interpret line graphs, bar graphs, and scattergrams.
- Design and conduct experiments that investigate one variable.
- Utilize accurate data collection and data recording methods.
- Apply information to design a system to solve a specific problem.
- Identify the appropriate data collection method (Sample, Simulation, or Experiment) to use for a specific problem.
- Compare and contrast factors of soil samples that might affect growth.
- Propose the best soil type for a given plant.
- Develop an understanding of changing materials to solve a structural problem.
- Add, subtract, multiply, and divide positive and negative integers and decimals.
- Use a checking account.
- Use a spreadsheet.
- Demonstrate cooperative decision-making skills.
- Identify parts of a seed.
- Use information from a given working drawing and schematic to prepare a Bill of Materials.
- Use scale drawing techniques.
- Relate the green color to leaf pigmentation and production of food from observations of a plant.
- Design electrical and fluid systems that work in harmony with the growth cycle for selected plants.
- Develop and implement a growing environment in a hydroponics system.
- Calculate the mean and median and find the mode.
- Display data using the appropriate graph.
- Compare and contrast flower structures.
- Demonstrate the ability to use tools/equipment safely.
- Design and generate a growing environment using principles of electrical and fluid systems.
- Evaluate and suggest improvements for a hydroponics system.
- Utilize tests and monitors to gather data for a growing environment.
- Compute and accurately measure the crop after harvesting.
- Assess the effectiveness of the system and make adjustments for future crops.
- Assess the value of hydroponics and its use as a component of food production.

WASTE MANAGEMENT

- Calculate the surface area of a rectangular prism.
- Calculate the volume of a rectangular prism.
- Calculate the least surface area of boxes when volume is constant.
- Conduct a controlled experiment to investigate the variables that influence composting.
- Categorize waste materials by their characteristics.
- Describe and analyze waste problems and suggest solutions.
- Redesign a given package, minimizing surface area and maximizing volume, to demonstrate the concept of "reduce."
- Calculate the volume of an irregular shape.
- Determine the volume and efficiency of an irregularly shaped package.
- Use the characteristics of materials to develop a method of separating the materials in garbage.
- Develop a product to demonstrate the concept of "reuse."
- Calculate the surface area and volume of a cylinder.
- Calculate and use ratios and percentages.
- Formulate testable explanations for observed phenomena.
- Demonstrate a method that will reduce volume and increase the efficiency of handling waste material.
- Construct and interpret graphs which relate to waste management.
- Describe the difference between a landfill and a dump.
- Identify the problems and benefits of landfills compared to other waste disposal methods.
- Use research skills to determine the environmental and economic impacts from waste management.
- Formulate recommendations for a waste management plan to a specific target group.
- Identify the conditions that are necessary for successful composting.
- Describe the advantages and disadvantages of home composting.
- Compare composted soil to noncomposted soil.

ENERGY TRANSFORMATIONS

- Construct appropriate types of graphs (bar, line, circle) for data.
- Calculate unit costs.
- Use ratio and percent to compare part-to-part and part-to-whole.
- Classify organisms as producers, consumers, scavengers, and decomposers.
- Construct a food chain to show the flow of energy (calories).
- Transfer energy from solar to electrical mechanical energy.
- Design simple electronic circuits for a given function.
- Use a spreadsheet to provide information about quantities.
- State the variables that affect the calories absorbed by a calorimeter.
- Use the equation for calculating calories correctly.
- Transfer wind energy to mechanical energy, then into electrical energy.
- Convert between standard numbers and scientific notation.
- Write large numbers in scientific notation.
- Explain the use of exponents.
- Create a concept map to show the main ideas and connections between Food Production, Wellness, Waste Management, and Energy Transformations.
- Determine which fuels are practical and efficient energy providers.

MANUFACTURING

- Classify sample materials according to their observable characteristics.
- Classify sample materials according to four categories used in manufacturing.
- Design, build, and use jigs and fixtures to control a tool and/or workpiece during manufacturing processing.
- Estimate length in metric or standard measure.
- Measure for precision using metric or standard measure.
- Conduct investigations of the interactions of materials by collecting information and controlling variables to establish desired properties.
- Design a process for making a small manufactured prototype using standard stock.
- Calculate equivalent forms of whole numbers, fractions, and mixed numbers.
- Add and subtract any combination of whole numbers, fractions, and mixed numbers.
- Determine the volume of a material by calculation and by water displacement.
- Determine the density of a material.
- Explain the need for interchangeable parts.
- Identify the differences among components, subassemblies, and finished products.
- Multiply any combination of whole numbers, fractions, and mixed numbers.
- Classify materials as acidic, basic, or neutral based on observable characteristics.
- Determine if substances react based on visual evidence.
- Identify and control the variables that lead to corrosion.
- Explain and use a design process.
- Design and build a mock-up and prototype of a product.
- Design and make packaging for the selected product.
- Prepare and administer a market survey for the selected product.
- Prepare, administer, and evaluate a market survey questionnaire for a selected product.
- Divide any combinations of whole numbers, fractions, and mixed numbers.
- Classify sample materials according to their thermal, electrical, magnetic, optical, and mechanical properties.
- Use geoboards to find the area of triangles and parallelograms.
- Develop rules about finding area of triangles and parallelograms.
- Choose the best material based on its thermal, electrical, magnetic, optical, mechanical, chemical and/or physical properties given the needs of a project and a list of available materials.
- Participate in roles of Total Quality Management subsystems.
- Operate the tools and machines used to manufacture a product safely and correctly.
- Determine the properties of parallelograms and triangles.
- Use geometry to find the Pythagorean Theorem.
- Conduct investigations to test materials to determine their strength, flammability, porosity, solubility, resistance to scratches, and adhesive nature.
- Organize and operate a pilot production run.
- Analyze problems discovered in the pilot production run.
- Express in percent the number of acceptable parts and unacceptable parts within the tolerance interval.
- Participate in a manufacturing production run and produce a set number of products.
- Construct a PERT chart to improve production efficiency of the IMaST product.
- Identify some of the environmental effects on materials and/or the behavior of living things in the environment under normal or extreme conditions.
- Calculate the break-even point.
- Determine a retail price for your product.
- Select, identify, or produce materials based on their composition, cost, and use.
- Determine appropriate methods of storage of materials and disposal of waste products.

FORECASTING

- Name points on the coordinate grid using ordered pairs.
- Observe, collect, and record data in numerical and graphical forms.
- Gather and record quantitative data.
- Gather and record qualitative data.
- Determine the effect of changing one variable in the pendulum system.
- Use various methods for organizing data.
- Select the best method for communicating quantitative and qualitative information.
- Draw a best fit line for a set of plotted data points.
- Describe patterns using the best fit line.
- Identify relationships between physical characteristics data and performance data.
- Formulate general *rules* regarding relationships between physical characteristics data and performance data.
- Design and build a product based on research.
- Draw best fit lines and use graphs to make predictions.
- Predict the effect of variables on the temperature of a salt and water mixture.
- Determine rate using a formula.
- Translate equations into graph form.
- Predict the effect of variables on the elasticity of a spring or rubber band.
- Test the accuracy of general rules developed through research.
- Analyze the performance of a product.
- Describe slope of a line on a coordinate graph.
- Describe the relationship between the coordinates of any two points on a line and the slope (rate of change).
- Use the principle of center of mass to balance an object.
- Translate an English expression into an algebraic expression using a variable.
- Determine air flow around objects of various shapes.
- Design and conduct experiments to determine aerodynamic characteristics such as lift and drag of various shapes.
- Collect like terms in an equation.
- Predict the effect of changing the pressure or volume of a gas.
- Use a ratio to enlarge a product.
- Construct a product using specifications.
- Control the flight of an airplane by adjusting moveable control surfaces.
- Predict performance of a product.
- Determine the mathematical equation from plotted data.
- Use the equation to determine the Fahrenheit or Celsius temperature when the other is known.
- Solve equations using the property of opposites and the property of reciprocals.

Activity Objectives for Eighth Grade

Module | **Objective** (Students will be able to:)

ANIMAL HABITATS

- Graph functions on a graphing calculator
- Plot data points and determine lines of best fit.
- Determine the potential carrying capacity of a habitat using the relationship of area of the base of a rectangular prism to volume.
- Use sampling techniques to determine carrying capacity of a habitat.
- Set up a ratio and rename as a percent.
- Make predictions about heredity based on data gathered through sampling techniques.
- Make predictions based on probability
- Design a chart and a tree diagram to illustrate the total number of possible outcomes.
- Identify the Fibonacci Sequence.
- Produce and interpret functions that demonstrate exponential changes.
- Develop actuarial tables for an animal based on life expectancies.
- Determine the ratio and percentage of dominant and recessive traits.
- Analyze the results of an experiment using DAPIC.
- Analyze a given situation using the requirements that are necessary to sustain life.
- Design, adjust, or describe a closed ecosystem that will allow a carbon dioxide/oxygen cycle to exist.
- Specify optimum conditions for growth of a given organism through experimentation.
- Predict when, how, and why osmosis will occur in a given ecosystem under certain conditions.
- Identify physical adaptations and indicate how they allow survival in the organism's habitat.
- Identify behaviors and indicate how they allow survival in the organism's habitat.
- Describe how animal interactions affect the ability of organisms to acquire their life requirements.
- Use various technologies to gather information related to animals.
- Use a problem-solving strategy to create a design brief.
- Use sketching techniques to illustrate the size and shape of a given animal habitat.
- Build a scale model according to a drawing.
- Select and use appropriate materials and techniques to make a model.
- Design and build a shelter or a support system to enhance an animal's habitat.
  (OR)
- Design and build a complete habitat that will allow a given animal to exhibit natural behaviors while in captivity.
- Identify and select appropriate sensors and appliances for use in controlling heat, light, humidity, and/or the flow of fluids.
- Develop a system that controls the heat, light, humidity, and/or flow of fluids in a habitat.
- Illustrate and provide a rationale for the arrangement of a given listing of animals in a mini-zoo.

HUMAN SETTLEMENTS

- Calculate parts per million.
- Develop the relationship between lateral surface and volume for a triangular prism, a square prism, and a cylinder to determine the benefits and drawbacks of carrying capacity of different water-carrying structures.
- Identify the shapes in architecture and determine characteristics of structural stability.
- Develop conjectures about relationships among angles.
- Develop conjectures about relationships among triangles and cause for structural stability.
- Calculate the measures and relationship of angles and polygons.
- Describe the relationship of the number of sides of a polygon and the measures of the angles.
- Tessellate polygons and use properties of forms to construct a tessellation design.
- Identify natural and human-made resources which influence global and national population patterns.
- Describe how water moves in an ecosystem.
- Design experiments which will identify water by its unique properties.
- Use heating and cooling concepts to design a home to allow for more efficient use of energy resources.
- Identify the amounts of potential and kinetic energy of an object in a given situation.
- Identify energy conversions and use them in order to solve problems.
- Analyze the advantages and disadvantages of various methods of electrical generation including environmental impacts.
- Identify the essential resources needed to develop and sustain a community.
- Design and build structures using conventional and innovative techniques.
- Determine essential city services and design a city using major zones to provide its sustainability.
- (Given parameters) design systems that provide fresh water collection and distribution, waste water collection and treatment,storm water collection and disposal, energy production and distribution, and transportation.
- Create a sustainable human settlements that includes residential, commercial, and industrial zones.

SYSTEMS

- Use the systems model to solve equations and determine the limits placed on a system.
- Generalize patterns in a sequence of algebraic equations.
- Collect, graph, and discuss data based on an experiment.
- Describe the relationship between drop height and bounce height using words, symbols, graphs, and equations to determine if the relationship between variables is a direct variation.
- Identify the relationships among variables.
- Determine the effect of changing one variable on other variables.
- Draw an ellipse and calculate the eccentricity of an ellipse.
- Identify the relationship between the length of the major axis, the distance between the foci, the eccentricity, and the shape of an ellipse.
- Translate word problems to systems of equations and solve by graphing.
- Explore the properties and functions of numbers systems other than and including base ten to determine the properties and functions of the metric system.
- Describe how the system functions.
- Produce a model that compares various attributes of objects.
- Apply Newton's laws of motion to describe how forces affect a given system of objects or events.
- Predict the effect of gravity on objects.
- Describe how the Sun-Earth-Moon subsystem interact.
- Describe why the seasons occur and predict seasons in different locations on the Earth.
- Distinguish between natural and human-made (technological) systems.
- Analyze and describe the function of technological systems used in everyday life.
- Classify common devices into one of three technological systems.
- Identify the basic parts common to all technological systems and how the basic system parts relate to one another and to natural systems.
- Break a given complex system into subsystems.
- Describe the function of each subsystem and how each contributes to the overall system.
- Design and build a closed loop system that achieves a desired result.

COMMUNICATION PATHWAYS

- Identify the components and functions of a mathematical system.
- Hide data by encoding and decoding messages.
- Develop a tracking method for large amounts of data.
- Synchronize and compress data while retaining readability.
- Identify pathways as connected graphs.
- Identify the components of an Eulerian Circuit and a Hamiltonian Circuit.
- Determine strategies for finding efficient Eulerian and Hamiltonian Circuits.
- Construct matrices that list the number of pathways among vertices.
- Determine the sum of two matrices.
- Use the calculator to sum matrices.
- Determine the number of ways a task can be completed.
- Use the calculator to multiply matrices.
- Interpret the powers of matrices of graphs.
- Analyze the sound from a single tone produced by a tuning fork.
- Change the graph of the cyclic curve y = sine x to match the data produced by the tuning fork.
- Determine the amplitude, frequency, and period for data.
- Analyze the light produced by a florescent light bulb.
- Change the graph of the cyclic curve y = sine x to match the data produced by the light.
- Determine the amplitude, frequency, and period for data.
- Differentiate between objects that conduct electricity and those that do not.
- Build series and parallel circuits from a circuit diagram.
- Predict the current amperage and flow in various circuits.
- Describe the relationships in a given appliance between magnetism and electricity
- Use the properties of waves to predict the outcome when changing variables in a wave experiment.
- Use the spectrum to describe natural phenomena.
- Describe reflection and refraction of light rays in various situations.
- Distinguish among important properties of sound, including amplitude, frequency, and wavelength in various situations.
- Design a communication device that synthesizes information from throughout the module, "Communication Pathways," using electromagnetism, sound, and light waves to communicate a message to others.
- Be able to describe how messages get from one place to another.
- Be able to illustrate the operation of a FAX machine.
- Utilize the basic components in an electric circuit.
- Predict the performance of an electronic circuit by analyzing a given schematic.
- Be aware that resistors have different values to control the current of a circuit.
- Be aware that transistors switch and/or amplify the flow of electrons in a circuit.
- Describe the ways in which lasers differ from ordinary light, and how different types of lasers are used for different types of applications.
- Describe the principles involved in sending and receiving messages using laser light.
- Understand how magnetism, electromagnets, and vibration can be used to produce sound waves used to communicate.
- Explain and illustrate how a message gets from an announcer at a radio station to a radio listener.
- Compare broadcasting to communication systems that depend on wires.

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Organization/Address: 5960 CeMaST Illinois State University Normal, IL 61790-5960	Telephone: 309 438-3089 / FAX: 438-3592
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