Roamer and the National Standards for Mathematics

These notes comment on Roamer's relevance to the American National Standards for Mathematics. Text written in **bold** paraphrase the standards.

1. **MATHEMATICALLY LITERATE WORKERS (p4) Industry's expectations for new employees:**

    a. **Workers will need the ability to set and solve problems as part of a team.**

    Most Roamer activities involve children working collectively: Sometimes as part of a "think tank". Other times by sub-dividing the problem into individual tasks whose outcomes are integrated into a final solution.

    Example: Space Journey A Roamer space ship has to make a journey to a distant planet. It interweaves its way round other planets, asteroids, etc. The distance it can travel is limited: Can it reach its destination or does it need to land and refuel? This activity is done with a small group of students and provokes discussion on a range of possible strategies.

    Workcard Activity - Roamer Play: Students devise a drama using robot characters. Each student programs one of the characters in a way that integrates with the script.

    b. **Workers will need a broad understanding of mathematics and how it can be used to solve problems.**

    Roamer is an object to think with. Students program it to solve problems which contain mathematical challenges. Activities which reflect an every day problem reveal the practicality of math and how relevant it is to our society.

    Example - Roamer Longshoreman: A number of ships are docked at the pier. Each contains mixed cargo. These need to be transferred to one of several warehouses. Each warehouse should store one type of goods. Students should program the robot to unload the ships. They are only capable of carrying three items at once. Students should gradually refine their solution to find the most efficient way.

2. **LIFE LONG LEARNING(p4)**

    Future citizens will need to be flexible and constantly learning. Mathematical skill is a key ingredient in their ability to do this.

    Roamer develops life skills: problem solving, synthesis, and communication in a group working environment. It is also an interdisciplinary tool which highlights the mathematical aspects of many different subjects.

    Example - Wagon Train: Roamer hits the Oregon Trail. Which way should it go? As scout and wagon master, the students have to decide. In most Roamer activities of this type, students realize many problems do not have one answer. A bad solution may simply be a step toward a right answer. They experience the value of communicating and discussing ideas, and that sources of inspiration or information can come from any place or anyone, but they need to be able to listen and learn if they are to seize the opportunity.

3. **OPPORTUNITY FOR ALL (p4)**

    It is important that all students become mathematically literate. Mathematics needs to exhibit social, culture and gender of the students.

Roamer is deliberately non-sexist and racist. It can be used as a means of self-expression. The same activity, exploring the same ideas and processes, can be done in a way, which relate to the specific circumstance of the student.

Example: Dancing Roamers: Program two Roamers to dance: this could be a square dance, a Native American, Hispanic, traditional African dance, etc.

4. NEW GOALS FOR STUDENTS (p5)

The aims should be to develop in students: an appreciation of math, confidence in their ability to use it, particularly in problem solving, and the skill to use it in communicating and reasoning mathematically.

Fun in mathematics is a foundation for achieving all these objectives. Children love playing with robots and look forward to doing math with Roamer.

Workcard Example - Estimation Game: A number is randomly selected. A student programs Roamer to move that distance. Other students stand where they think Roamer will stop.

Example - Soccer: Taking turns, each side programs Roamer to hit a ball and score a goal.

To achieve the aims of the standards, the student should "gain mathematical power". This means developing the ability to explore, conjecture and reason logically, as well as the ability to use different mathematical methods to solve non routine problems.

Many Roamer problems are based on the world familiar to the student. Others can be inspired by fantasy worlds. Such unconventional problems help empower students mathematically.

Example - Alien Visitors: An alien robot lands on Earth. Devise a robot communication system to enable the Roamer to talk to it. Possibilities include using the Roamer's sound facility or a body of language. The latter can involve movement; or if using the Roamer control facilities, it can involve lights and moving "tentacles". Students should communicate through the Roamer.

Students should learn to value mathematics through experience of its cultural, historical and scientific evolution.

Roamer offers endless opportunity to present problems in exciting ways.

Example - Time Traveling Roamer: Roamer travels back in time and invents geometry. Starting with measuring (to help a caveman build a bridge across a river), the robot helps build the pyramids (using Roamer's drawing feature to draw nets) before working with Pythagorous on polygons and Archimedes on the circle.

The students need to become confident in their mathematical ability. This can be developed by solving problems around them.

Roamer can be used to model solutions to real life problems.

Workcard Example - Supply and Demand: Various cities have unequal stocks of tea, coffee, milk and sugar. A Roamer truck has to be programmed to deliver appropriate commodities between locations to balance out the stocks. Different criteria are progressively introduced: like restricting the number of items carried on each journey, finding the most efficient way and adding a value to each item delivered.

Students should become mathematical problem solvers. Activities should vary from simple tasks solvable in an hour to projects that can take days or weeks to conclude.

Problems with more than one right answer should be included.

Roamer activities can be tailored to meet the specific needs of the teacher, student and timetable.

Workcard Example - Bus Routes: (See 4.6 and 5.2.3) At its simplest, students program Roamer to make a bus journey. The activity can be extended: Where should the bus stops be located? How long should the bus stop at each stop? and write a bus time schedule. At each stage Roamer is used to model the students solution. Students should not guess. Instead they are expected to study local bus systems, gather data (often from field visits) and find ways to make realistic estimates.

Students should be encouraged to communicate mathematically by reading, writing and discussing the subject and their ideas about it.

Roamer activities can present children with a first knowledge of a concept. Sometimes they do not have the language or knowledge to describe the situation, but readily express themselves in a language they find meaningful. Other aspects of Roamer work involves writing problem statements, discussing possible solutions and recording the progress to a solution.

Workcard Example - Estimation: Several tasks are set which require students to estimate distance and angle. Typically they may not know the name of units or what they mean. They develop a language like "Roamer units" and use everyday language in mathematical context: like "further than" or "less than".

Workcard Example - Bus Routes: (See notes 4.5 and 5.2.3) In this activity students need to record data and explain reasons for choices and decisions.

It is important that students develop mathematical reasoning and thinking skill. The attributes should be rewarded even more than "finding a right answer".

Roamer offers opportunities to develop an understanding of mathematical methods and fosters the fundamental mathematical thinking skills. With Roamer, children can try and see what happens, analyze results and see the consequences. They can have a theorem and test it, modify it, etc.

Workcard Example - Number: (This is an extension to activity 5.1) Having work on some basic skills of arithmetic, students are asked to solve the following problem: a newspaper boy/girl has to deliver papers to two houses and then go home. Does it matter in which order they deliver them? Students are expected to develop a theory and a proof and use Roamer to confirm their ideas.

Students mathematical literacy denotes their ability to explore, conjecture, reason logically, refine and develop ideas using a variety of mathematical techniques.

The Roamer does offer some interesting opportunities to develop an understanding of mathematical methods.

Example - Iteration: Many Roamer problems are solved by making an estimate, and then adopting a systematic method of adjustment to arrive at a satisfactory answer.

Example - Convergence: Roamer moves and turns in a Logo/Turtle fashion. Students can explore how the shapes produced converge by making methodical changes to the distance moved and turned.

5. MATHEMATICS (p7)

Traditionally, mathematical knowledge has been the sole objective of teaching the subject.

The standards do not dismiss the importance of knowledge, but adds to it the need to develop mathematics thinking skills.

Roamer can be used to provide practical experience of math knowledge in a way which explores the discipline of the subject.

Workcard Example - Number: These activities involve students in addition and subtraction. It combines Roamer and a number line. They perform the tasks mentally, but Roamer provides them with a concrete means of visualizing the problem and testing their answer and at the same time asks them to consider underlying rules like the commutative law. The final activities (see 4.7) asks them to use their knowledge to solve a problem.

Three features of Mathematics are embedded in the standards:

Knowing mathematics is doing mathematics:

Roamer is a math manipulative and students make it do things. It provides a practical way to explore a wide range of mathematical ideas.

Example - Treasure Island: Place a compass on the Roamer and program it to follow some coded instructions and find some hidden treasure. At various points in the trial, students have to solve some puzzles. In this activity Roamer's scaling feature can be used, so that angles of turn sometimes relate to compass directions and sometimes to degrees. To be successful students have to use the compass properly and understand how it relates to degrees and movement.

Mathematics has changed. Traditional ideas (arithmetic, geometry, algebra & calculus) found applications in science and technology students. New fundamental ideas (mathematical models, structures, & simulations) now find application in areas as diverse as business, life and social studies. The curriculum needs to provide opportunities to explore these new ideas in a variety of ways.

Roamer can be used to explore many of the traditional ideas, like geometry, but it is particularly adept at developing problem solving and mathematical modeling skills to solve the newer type of problem..

Example Activity: Make Roamer into a dog. How do you program a robot to behave like a dog? Should it be a pet, a guard dog, a sheep dog, etc.? Students need to observe, analyze and then devise a program that would simulate the dog's behavior.

Technology has changed the discipline of mathematics. Calculators and computers offer new opportunities and the standards recommend a computer in every classroom and that students should have access to them for individual or group work.

A computer in every classroom offers exciting possibilities. However there are practical problems. In countries like England, most classrooms have one or more computers, but access time for mathematical activity is limited, particularly when the math computer time is competing with word processing and other computer applications. Roamer is a computer. Programming Roamer utilizes the same techniques as conventional computer programming and is particularly useful in investigating and problem solving. That is not to say the Roamer can replace the use of personal computers, but it can be used to supplement and relieve the demand on them.

Workcard Example - Bus Routes: (See 4.5 and 4.6) The preliminary work on the bus can be done with the Roamer. However by using *Roamer World* software, the activity can be extended to include work on the computer. For example, the activity can be extended to

simulate an entire transport system.

The content and approach to mathematics should be appropriate to all students, irrespective of gender or race.

Roamer is a creative tool which can be used in many different contexts. The same mathematical activity can be approached in many different ways. The activity can be defined by the teacher or by students as a means of self expression or relevant to their circumstance.

An important factor in achieving acceptance of math amongst a diverse populace is the ability of individuals to engage with the subject. Roamer is very successful at this. In many Roamer activities students can set their own goals and decide when they've achieved them. Children get a great thrill from controlling a robot and a real sense of achievement when they attain their objective.

Example - Integrated Math and Technology: Two groups engaged on similar projects which involved making a robot which could collect some objects and transport them to a different location. One group of boys made a robot move hazardous waste objects. The other group comprised of girls decided to make a robot that would collect the mail for old or disabled people.

6. STUDENT ACTIVITIES (p9)

Mathematical knowledge often emerges from experience of problem solving.

The essence of Roamer's usefulness is the easy way a large range of problems can be set. The same problem can be presented in a simple or complex manner. Often the complexity grows the further the student explores the activity as they discover more mathematical problems.

Workcard Example - Number: (This activity is a potential extension of 5.1) When students are exploring the idea of subtraction using Roamer and a number line, they discover that it is important to subtract the small number from the large one. What happens if they do it the other way around? They discover that the robot can do it and they end up with a result their knowledge cannot explain. This is a perfect opportunity to start to explore negative numbers.

Example - Going on a Journey: Sending Roamers on journeys is a typical problem enabling children to explore ideas of geometry, measurement and estimation. Once they've completed the journey, could they use Roamer to draw a map of it? This offers opportunities to explore the ideas of scale and similarity.

The way mathematics is taught should include opportunities for:

- *** Appropriate project work**
- *** Group work**
- *** Discussion between teacher and students and among students**
- *** Practice on mathematical methods**
- *** Exposition by the teacher**

The many examples cited illustrate how Roamer can be used to meet the first three of these criteria. The last one is a matter for the teacher.