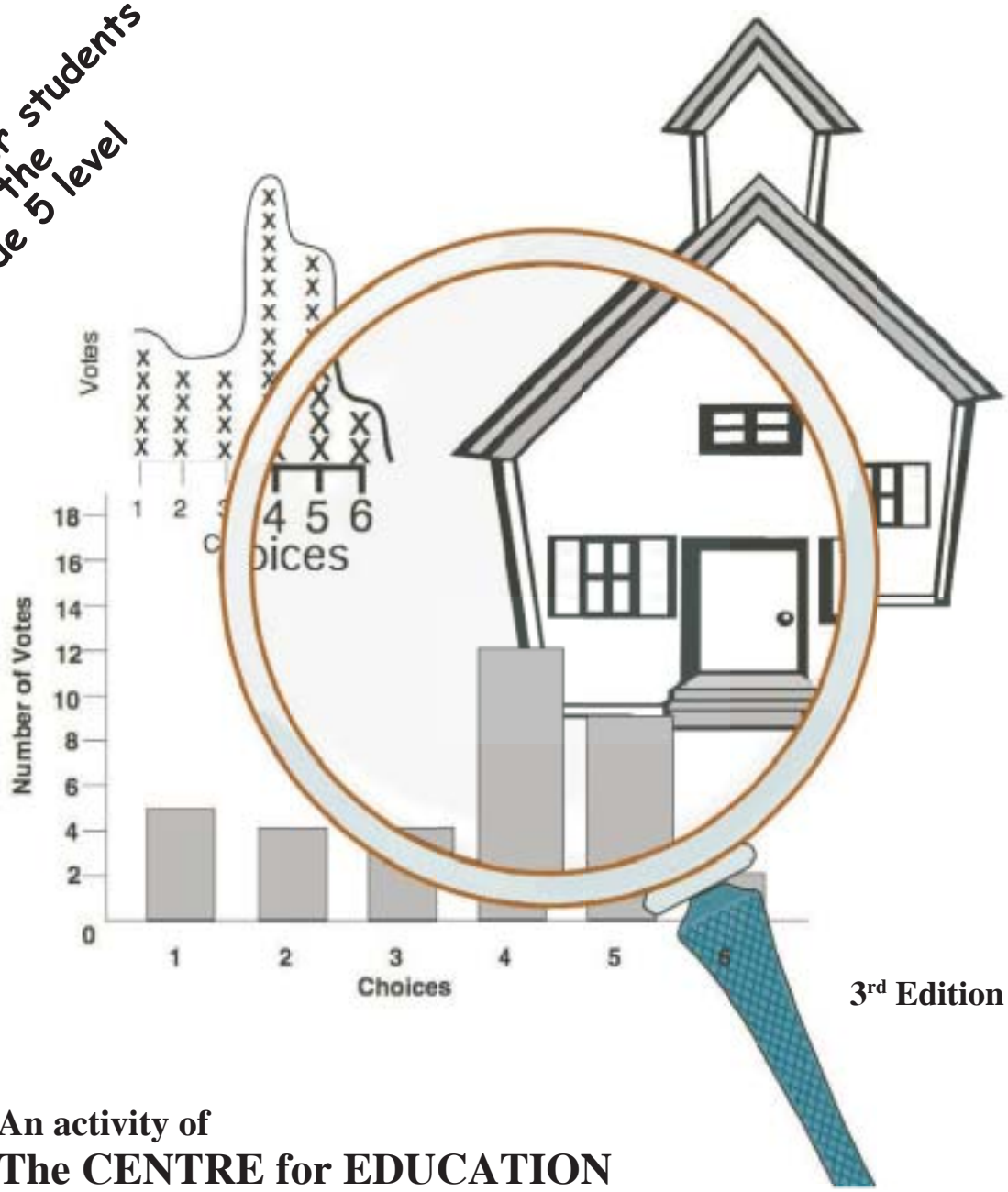
Invitations to Mathematics

Investigations in Data Management

"How About Our School?!"

Suggested for students at the Grade 5 level



3rd Edition

An activity of
The CENTRE for EDUCATION
in MATHEMATICS and COMPUTING
Faculty of Mathematics, University of Waterloo
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Preface

The Centre for Education in Mathematics and Computing at the University of Waterloo is dedicated to the development of materials and workshops that promote effective learning and teaching of mathematics. This unit is part of a project designed to assist teachers of Grades 4, 5, and 6 in stimulating interest, competence, and pleasure in mathematics, among their students. While the activities are appropriate for either individual or group work, the latter is a particular focus of this effort. Students will be engaged in collaborative activities which will allow them to construct their own meanings and understanding. This emphasis, plus the extensions and related activities included with individual activities/projects, provide ample scope for all students' interests and ability levels. Related "Family Math" activities to involve the students' parents/care givers are also suggested.

Each unit consists of a sequence of activities intended to occupy about one week of daily classes; however, teachers may choose to take extra time to explore the activities and extensions in more depth. The units have been designed for specific grades, but need not be so restricted. Activities are related to the Ontario Curriculum but are easily adaptable to other locales.

Investigations in Data Management is comprised of activities to enhance the students' abilities to collect, represent, and interpret data, frequently in a problem-solving mode. Since today's media make constant use of data presented in various forms (often in order to sway opinion), it is especially important to help students learn to read and interpret these graphs, charts, or tables. Data management is equally important in the depth and variety of its connections to other subjects such as environmental studies.

Information on all the available units in the ***Invitations to Mathematics*** series can be found at the end of this booklet.

Acknowledgements

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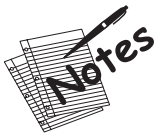


Common Beliefs

The activities in this booklet have been developed within the context of certain beliefs and values about mathematics generally, and data management specifically. Some of these beliefs are described below.

Importance of Statistics

In an information-rich society such as ours, statistics are an increasingly important aspect of daily life. "Educators and mathematicians now stress the importance of incorporating data analysis in the elementary mathematics curriculum to prepare students for living and working in a world filled with information based on data."

Corwin and Russell

Connections to Other Curriculum Subjects and Mathematics Strands

Activities which involve data management can provide a meaningful link to other content areas such as environmental studies and science. These activities help students to develop critical-thinking and problem-solving skills, and can reinforce communication skills as students discuss and write about their conclusions. Within mathematics, these activities provide opportunities for students to represent, interpret, and discuss information, as well as estimate, measure and develop number sense.

Connections to the Real World

Through collecting and analyzing real data, students encounter the uncertainty and intrigue of real mathematics. "We are living in a world of information. Stop and think a moment about the number of facts, figures, and other data that confront us each day. What do we do with all this information? We ignore some of it, we organize some of it to fit what we already know, or we summarize it by using shorter descriptions or other numbers. How is this information presented to us? It may be presented in written descriptions, in graphs or tables or in summary numbers such as averages. How do we learn to make sense of all this information? This is where we, the K-6 teachers and teacher educators, enter the picture; we need to help our students - from the time they first enter school - to make sense of data."

National Council of Teachers of Mathematics (NCTM)

GOOD TASKS ARE ONES THAT DO NOT SEPARATE MATHEMATICAL THINKING FROM MATHEMATICAL CONCEPTS OR SKILLS, THAT CAPTURE STUDENTS' CURIOSITY AND INVITE THEM TO SPECULATE AND TO PURSUE THEIR HUNCHES.

NCTM

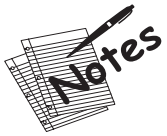
Importance of Language

A central activity in data analysis is dialogue and discussion. In a classroom setting, a significant amount of time should be devoted to reflection, discussion, and writing about the meaning of the data.

Importance of Real Data

In data analysis, students use numbers to describe, compare, predict, and make decisions. Because real data are used, there are no predetermined "answers". "Not only do you not know the answer [to the investigation] in advance, but, without seeing the data, you may not even know what the most interesting questions are going to be!"

Corwin and Russell



Data management is more than reading and interpreting graphs; it is describing and interpreting the world around us with numbers, and is a tool for solving problems.

NCTM Standards, 1989

Overview

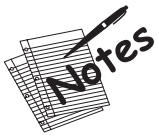
Essential Content

The activities in this unit focus on the collection, organization, analysis, representation, and interpretation of data.

During this unit, the student will:

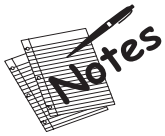
- use a variety of methods to collect data within the school;
- develop and implement survey and presentation procedures;
- use the strategy of brainstorming to develop school improvement strategies;
- construct line and bar graphs to represent the data;
- describe and interpret the data guided by a set of prepared questions;
- pose questions and seek solutions based on manipulation of the data;
- use a variety of problem-solving strategies.

Overview



CURRICULUM CONNECTIONS

ACTIVITY	DESCRIPTION OF THE ACTIVITY	CURRICULUM EXPECTATIONS
Activity 1 **Exploring Our Class's Attitudes**	• predicting results of a survey • constructing and interpreting a line plot	• interpret displays of data • evaluate data presented on tables, charts, and graphs
Activity 2 **Developing a Survey of Our School**	• devising a survey form • predicting results of a survey	• design surveys, collect data, and record the results on tally charts
Activity 3 **Collecting and Displaying Data**	• organizing a survey and collecting survey data • interpreting the collected data • constructing and interpreting line plots	• design surveys, collect data, and record the results • display data on graphs • analyse how data were collected and discuss the reasonableness of the results
Activity 4 **From Line Plots to Bar Graphs**	• construction a line plot and a bar graph • identifying components of graphs and comparing different types of graphs • describing the collected data	• interpret displays of data and present the information using mathematical terms • explain the choice of intervals used to construct a bar graph • evaluate data presented on tables, charts, and graphs
Activity 5 **From Data to Action**	• analysing data collected by all groups, both orally and in writing • using mathematical language • using the collected data to suggest other surveys	• evaluate data presented on tables, charts, and graphs • interpret displays of data and present the information using mathematical terms



ASSESSMENT

Assessment is a process of gathering evidence about a student's knowledge, skills, and values, and of making inferences based on that evidence for a variety of purposes. These purposes include: making instructional decisions; monitoring student progress; evaluating student achievement in terms of defined criteria; and evaluating programs.

Attention should be given to a broad range of assessment practices such as:

- assessing what students know and how they think about mathematics;
- focusing on a broad range of mathematical tasks and taking a holistic view of mathematics;
- assessing student performance in a variety of ways, including written, oral, and demonstration forms;
- using calculators, computers, and manipulatives;
- recognizing such attitudinal outcomes as motivation and appreciation;
- assessing the process as well as the product.

Tests are one way of determining what students have learned, but mathematical competence involves such characteristics as the ability to communicate, problem-solving ability, higher-order thinking ability, creativity, persistence, and curiosity. Because of the nature of the activities it is suggested that a variety of types of assessment be used. Suggestions include:

(i) observing students as they work to see if they are applying various concepts; to see if they are working cooperatively; to observe their committment to the tasks;

(ii) assessing the completed project to see if instructions have been followed; to see if concepts have been applied correctly; to see if the language of mathematics has been used correctly;

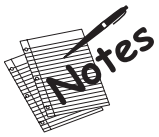
(iii) assessing the students' descriptions of their completed work to see if mathematical language is used correctly; to see if students understand the concepts used;

(iv) providing opportunities for student self-assessment: have students write explanations of their understanding, opinion, or feelings about an activity. One technique is to have them write under the headings What I Did, What I Learned, and How I Felt About It. Students could be asked to write a review of one day's activities or of the whole unit's work.

(v) selecting an exemplary piece of work to be included in a portfolio for assessment purposes or for sharing with parents.

See Suggested Assessment Strategies, page 41, for further discussion and sample rubrics.

Overview



PREREQUISITES

It would be helpful if students begin this unit with:

- a knowledge of essential characteristics and construction of graphs (particularly bar graphs);
- some experience working in small groups;
- some experience writing in journals to descrie concepts, justify solutions, and describe successful strategies, and
- understanding of simple fraction concepts (with possible conversion to percent).

LOGOS

The following logos, which are located in the margins, identify segments related

Problem Solving

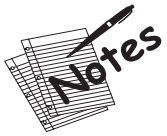
Communication

Assessment

Use of Technology

MATERIALS

ACTIVITY	MATERIALS
Activity 1 Exploring Our Class's Attitudes	• Copies of BLM 1 (optional) • Copies of BLM 2 for all students • Acetate copy of BLM 2 for use with an overhead projector • Copies of BLM 5 for all students (optional)
Activity 2 Developing a Survey of Our School	• Strips of chart paper (cut 4 to 6 strips from each page) • A copy of BLM 3 for each group • A copy of BLM 6 for each group (optional) • Markers
Activity 3 Collecting and Interpreting Survey Data	• A copy of BLM 6 for each group (optional) • Copies of BLM 1 as needed • Copies of BLMs 3 and 4 for all students • Acetate copies of BLMs 2 and 4
Activity 4 From Line Plots to Bar Graphs	• Acetate of copy BLM 4 • Copies of BLMs 9, 10 and 11 for all students (optional)
Activity 5 From Data to Action	• Acetate copy of BLM 4 • A copy of BLM 7 for each student • Calculators for each survey group (optional) • Copies of BLM 8 for all students (optional)



Letter to Parents

SCHOOL LETTERHEAD

DATE

Dear Parent(s)/Guardian(s):

For the next week students in our classroom will be participating in a unit titled "How About Our School?!". The classroom activities will focus on data collection and organization, and graph creation and interpretation.

You can assist your child in understanding the relevant concepts by working together to look for situations where graphs might be used, and by helping in the collection of data for the purpose of creating graphs.

Various family activities have been planned for use throughout this unit. Helping your child with the completion of these will enhance his/her understanding of the concepts involved.

If you work with graphs in your daily work or hobbies, please encourage your child to learn about this so that he/she can describe these activities to his/her classmates. If you would be willing to visit our classroom and share your experience with the class, please contact me.

Sincerely,

Teacher''s Signature

A Note to the Teacher:

If you make use of the suggested Family Activities, it is important to schedule class time for sharing and discussion of results.

Activity 1: Exploring Our Class's Attitudes

Focus of Activity

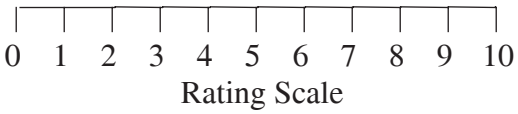
- Collection, recording, organization, and interpretation of data
- Independent and group work to generate ideas for improving specific attitudes as identified by surveys

What to Assess

- Prediction of possible results of a survey before gathering data
- Knowledge of the relevance of data collection in daily life
- Interpretion of data from a line plot (or "sketch graph")

Preparation

- Draw a large rating scale from 0 to 10 on the chalkboard, or chart paper.



- Provide an individual rating scale for each student by cutting in strips from copies of BLM 1 (optional).
- Prepare an overhead copy of BLM 2, plus one copy per student.
- Prepare one copy per student of BLM 5 (optional).

Communication

Activity:

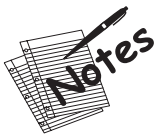
Collecting Data

Hold a brief discussion about the importance of gathering and representing data. Discuss ways that one can obtain information. Discuss kinds of information we encounter in daily life (e.g., census, television viewing preferences, awards for best film, opinion polls).

Show the Rating Scale on chart paper or chalkboard. Ask students what they think the numbers on the scale may mean. For this activity, 0 represents the lowest rating and 10 the highest, but students may suggest other interpretations.

Add the question "How do you rate our school?" as a title for the Rating Scale. Discuss with the students what this question might mean. You might wish to make a list of 'feelings' that the students suggest, and the reasons for them, such as: *Proud (of what?); Happy or sad (about what?); interested (in what?); secure, worried (about what?),...*

If desired, the (optional) individual rating scales (BLM 1) can be distributed at this point, and students can circle appropriate numbers for their own ratings. Collect the data from the students in the quickest and easiest way possible, such as asking them to close their eyes so they are not influenced by others, and calling out each number from 0 to 10, and counting raised hands. Record the data on a simple table such as that shown below.



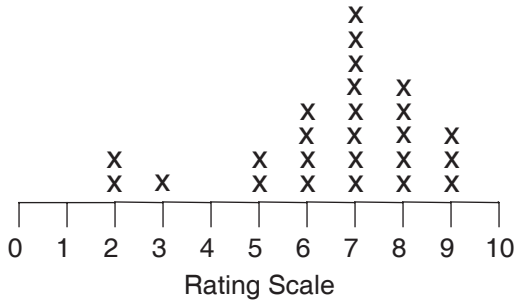
Activity 1: Exploring Our Class's Attitudes

Rating	Number of students
0	0
1	2
2	1
10	0

Problem

RECORDING DATA

Distribute copies of BLM 2 and place the overhead copy on the projector. Ask the students how the data from the chart could be placed on the rating scale in such a way that someone visiting the class would be able to tell how the students rated their school. Eventually, as the discussion progresses, an incomplete bar graph (sometimes called a "Line Plot") should emerge. Encourage the students to use *equal-sized symbols, equally spaced,* as you construct the graph together. One way to do this is to represent each student with a gummed square or a small Post-It™.



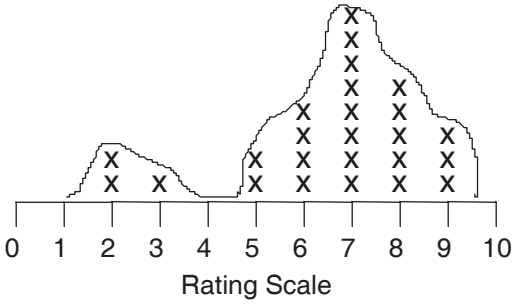
Briefly discuss the advantages of line plots; they are easy to use, and to interpret, particularly for opinion polls. Even though relatively unsophisticated, such graphs can reveal very useful information about general trends, and unusual features of data; they are a useful tool for students.

Activity 1: Exploring Our Class's Attitudes

Analysing Data

Use the overhead of BLM 2 to stimulate discussion about the Line Plot you have just created. You may wish to record key words on the overhead as students discuss (a), (b), (c), and (d). For question (e) you may wish to draw a smooth line over top of the "x"s to show the shape of the data more easily (e.g., mountains, valleys, etc.). Explain that such a line is often omitted in a Line Plot, but may be used if helpful. Ask the students what they think the graph tells them about their class's attitudes towards the school.

If time allows at this point, the students should complete their own responses to question 2 on their copies of BLM 2.



Ideas For Action

Focus the discussion around the question *What could our school do to improve the results of the ratings?* (i.e., How could our school rate a 10?) Ask students to think of all the ways that might improve the rating score. Include in your discussion some "impossible" ideas (e.g., a school trip to Europe, adding a pool to the school), as well as more practical ideas (e.g., having more play days).

Once some ideas have begun to surface, distribute copies of BLM 5 to all students, or write the instructions on the chalkboard or chart paper and have children respond in their notebooks or math journals. Have them work in pairs for a few minutes generating their own ideas. Encourage them to note any interesting thoughts on BLM 5, and then have them take it home to collect more ideas from family and friends. Remind students to bring BLM 5 back the next day.

Extensions in Mathematics

1. Conduct class surveys for other topics relevant to the school setting such as classroom chores, opening exercises, or displays/bulletin boards.

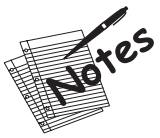
Cross-Curricular Activities

1. Have students write a personal explanation of their own ratings of the school.
2. Have students employ various forms of media to describe *The Ideal School*.
3. Discuss ways in which ratings are used in newspapers and magazines (e.g., TV ratings). Begin a classroom collection of print materials. (This collection would be useful for Activity 4.)

ADVANCE NOTICE:

By the end of Activity 2, you should have representative samples chosen for a survey planned in Activity 2 (e.g., a few primary and junior classes, some teachers.). You may want to ask permission of those teachers in advance for students to survey their class the following day.

Communication



Communication

Activity 1: Exploring Our Class's Attitudes

Family Activity

1. Ask students to compare their own school life with that of parents/guardians or grandparents. Share findings with the class.
2. Students might ask parents how they would have rated their own childhood school and what changes they would have liked to have seen.

Other Resources

For further details, see annotated Other Resources list on page 41, numbered as below.

2. "Dealing with Data and Chancer", Addenda Series, Grades 5 - 8

4. "Using a Database for Student Research" Mealy and Moyles

7. " Our Heritage: Learning Data - Management Skills Meaningfully," by Yvonne M. Pothier and Christine M. Nickerson

Activity 2: Developing A Survey of Our School

Focus of Activity

- Development of a survey, including identification of appropriate sample groups within the school

What to assess

- Analysis of a rating scale
- Reasonableness of predictions
- Relevance of survey questions
- Suitability of survey materials
- Collaboration with other group members

Preparation

- Provide paper and markers for recording ideas (e.g., cut one sheet of chart paper in 4-6 strips for each group.)
- Make copies of BLM 3, one per group of 4 - 6 students
- Make copies of BLM 6 for each group (optional)

Activity

Selecting Survey Questions

Working in groups of 4 - 6, have the students consolidate their ideas from their individual responses to the question on BLM 5. Each group should decide on 5 main suggestions and record them on individual strips of chart paper with a marker. Have the groups post their suggestions, one at a time, in rotation until all differing ideas have been posted. (This will avoid posting suggestions which are the same as some other group's, while allowing each group to post at least one or two.)

Allow each student to vote for three suggestions, using gummed circles/Post-Its™/markers, etc. Have the class rank the choices, based on the number of votes, and select the top 6 suggestions. They may fall into categories such as:

- Creative Playground
- Special Lunches
- Music on the PA
- Games Room
- More Computer Time
- Dress-up Days

Distribute copies of BLM 3 to each group. Have the students copy the top six suggestions onto BLM 3, as shown below.

Comments in italics are explanatory and need not be conveyed to the students.

Activity 2: Developing A Survey of Our School

Excerpt from BLM 3

Survey Data for _____

Choices	Total
1. Creative playground	
2. Special lunches	
3. Music on the PA	
4. Games room	
5. More computer time	
6. Dress-up days	

Finding a Representative Sample

Have the students think about the rating scale. Ask the question *How will we find out how others feel about our school?* Review the advantages of the rating scale used on Day 1 (e.g., it's easy to use, and easy to interpret).

Ask students to make some general predictions about the potential results. For example;

- *How might the results from our class be different from those of a grade 1 class? a grade 2 class? a grade 6 class? teachers?*
- *Do you think the attitudes of students will change as they move up the grades? Why?*

Refer the students to BLM 3. Ask the question *How will we find out what support there is for each of the choices that our class has developed? Who will we ask?* Develop a list of different groups in the school (e.g., school volunteers, teachers, primary students, junior students, support staff, parents).

Organizing Survey Teams

Divide the students in the class into survey teams of 2-4 students (depending on the number of groups being surveyed), and decide on which group each team will survey. (Since BLM 4 has space for just 6 survey groups, you may wish to choose 6 or fewer groups).

The Interview Process (TO BE DONE NOW OR AT THE START OF ACTIVITY 3)

As a preliminary activity to the actual collection of data from groups in the school, each survey team should practice basic surveying techniques. Discuss the importance of tone of voice, explaining the purpose of the survey, and knowing that young primary children may need to be surveyed differently from older students. For example, have students list the 4-6 choices on a sheet of experience chart paper. You may wish to have them modify the chart for primary children by (i) using simpler words, and/or (ii) including an appropriate

Notes

You may wish to discuss "representative sampling" at this point. For example, if your school has 6 primary and 6 junior classes, is it areasonable expectation to interview everyone? How would you decide what subset of classes to survey?

Problem Solving

REMINDER

By the end of Day 2, you should have the representative samples chosen (e.g., a few primary and junior classes, some teachers, etc.), and you should ask permission of those teachers for students to survey their class the following day at an appropriate time.

Activity 2: Developing A Survey of Our School

Communication

picture (e.g., the choice *More Physical Education Opportunities* could be rewritten as *More Gym*, and could be accompanied by a picture of a basketball net.) Alternatively, since the questions are to be presented orally (see (e), (f) below), discuss what wording would be appropriate for primary children.

Brainstorm (or prepare ahead of time) a list which describes the steps to be used to conduct the survey or distribute copies of BLM 6. For example,

a) State the general purpose of the survey.
b) Describe the two types of data being collected; i) rating scale, and ii) opinions on choices.
c) Give a rating scale to each person, asking students to circle the number which best reflects their feelings about the school.
d) Collect the completed rating scales.
e) Read the list of the 6 top choices for improvement.
f) Vote by a show of hands for each choice. (One vote per person only!).
g) Record the results for both rating scales and choices directly on the Survey (BLM 3).

Instruct each group to complete BLM 6 (or their own list of steps) in preparation for next day's surveys, and provide an opportunity for the groups to rehearse their presentations.

By the end of Activity 2, each team should feel confident of their ability to conduct the survey of their particular sample group.

Cross-Curricular Activities

1. Discuss how surveys of large groups of people might be taken. For example,
   opinion polls about such things as which music video is a best seller, or which canidate is likely to win an election.
2. Discuss the merits of surveys taken in person, by mail, by telephone or by email.

Family Activity

1. Conduct family surveys related to household issues such as organization of the kitchen, dialogue at dinner, the condition of the yard/balcony, assignment of chores. Record the opinions on a line plot with a numerical rating scale, perhaps grouping the data from several families. Brainstorm ways for improvement.

Other Resources

For further details, see annotated Other Resources list on page 41, numbered as below.

1. "Making Sense of Data", Addenda Series, Grades 5 - 8
6. " Consumer Investigations: What Is The 'Best Chip'". by Dixie Methany,
7. " Our Heritage: Learning Data - Management Skills Meaningfully," by Yvonne M. Pothier and Christine M. Nickerson

Activity 3: Collecting and Interpreting Survey Data

Focus of Activity

- Collection, display, and interpretation of data from the results of two surveys

What to assess

- Collection of data (e.g. were the questions presented so the survey group understood them? was data collected in an efficient manner?)
- Neatness and accuracy of line plot
- Interpretation of line plot
- Collaboration with others
- Use of appropriate language when presenting results to class

Preparation

- If you have not previously prepared an interview process (as in Activity 2), you may wish to prepare copies of BLM 6 for each group.
- Prepare sufficient individual rating scales for each group by cutting them in strips from copies of BLM 1.
- Conduct a quick inventory of materials needed by each group, such as:
  - sufficient individual rating scales for each class/group to be surveyed
  - at least one team copy of BLM 3.
- Prepare overhead transparencies of BLMs 2 and 4, plus individual copies of BLM 4.
- Provide experience chart paper and coloured markers.

Activity

The Interview Process (See Page 12)

If the survey process was not discussed in Activity 2, it should be discussed here.

Conducting the Survey

Ensure that the survey teams know where their sample group is located, and have all of the necessary data collection materials. Send the survey teams to collect the data from their identified groups. Instruct each team to record the responses carefully. You may wish to set a time limit for each group.

Recording the Data

Upon return, have each survey team sort its rating scale strips in order from least to greatest rating, and transfer the responses to the **Survey** (BLM 3). Ensure that each **Survey** sheet has been completed similar to the example below:

Activity 3: Collecting and Interpreting Survey Data

Excerpt from BLM 3

Survey Data for Grade 4

Choices	Total
1. Creative playground	2
2. Special lunches	13
3. Music on the PA	7
4. Games room	5
5. More computer time	4
6. Dress-up days	2

Scale	Number of Votes
0	0
1	0
2	2
3	5
4	7
5	6
6	4
7	3
8	1
9	1
10	0

Instruct each survey team to construct a line plot which represents the rating scale data for their team. Each graph should be drawn on experience chart paper, and then displayed upon completion.

Interpreting the Data

Have each survey team describe their data. Use the questions on BLM 2 to help students with their interpretation.

Have them describe the 'shape' of the data. For example, observations might include:

- most of the votes are at the right end of the scale;
- the votes are mainly in the middle with nothing at either end;
- there are gaps in the data;
- there are two big clumps of data at either end with nothing in the middle;
- the votes are pretty well even in the 5 -10 range.

Communication

As a class, discuss similarities and differences among the various line plots. For example, note whether the graphs from primary children are different from or the same as graphs from junior students. Discuss why data collected from teachers might be different from data collected from students.

Preparing for Activity 4

Using an overhead transparency of BLM 4, record the data from each survey team. Tabulate the total number of votes for each choice. For example,

Have students record these data on their copy of BLM 4, since this information will be necessary for Activities 4 and 5.

Activity 3: Collecting and Interpreting Survey Data

Excerpt from BLM 4

Survey Data

Choices	Survey Group #1	Survey Group #2	Survey Group #3	Total Number of Votes
1. Creative playground	2	4		
2. Special lunches	13	8		
3. Music on the PA	7	6		
4. Games room	5	10		
5. More computer time	4	3		
6. Dress-up days	2	4		

Cross-Curricular Activities

1. Have each student write about the experience of taking a survey, using questions and suggestions like the following as guides.

   Describe the survey-taking process. How did you make sure that people in your sample understood your questions? If you were to conduct the survey again, would you do anything differently? What? Why?

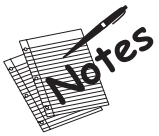
Communication

Other Resources

For further details, see annotated Other Resources list on page 41, numbered as below.

5. "Ideas", Joan Westley

Activity 4: From Line Plots to Bar Graphs



Focus of Activity

- Description and interpretation of data using bar graphs

What to Assess

- Construction and interpretation of line plots
- Construction and interpretation of bar graphs

Preparation

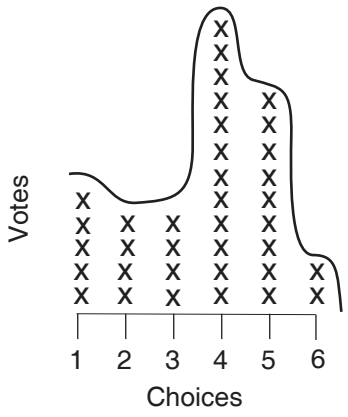
- Retrieve the existing overhead transparency of BLM 4.
- Make a copy of BLM 9 for each student (optional).
- Collect samples of a variety of graphs from magazines, newspapers (optional).
- Make overhead transparencies, and copies for each student of BLMs 10 and 11 (optional).

Activity

COLLECTING DATA

Conduct a class vote on the 6 choices, if this was not done earlier. Record the votes in the column labelled *Our Classroom* on the existing overhead transparency of BLM 4, and quickly recalculate the totals to include the class data and record on the overhead. Students should add this data to their copies of BLM 4.

Instruct students to draw a line plot representing the class data. Draw a smooth curve over the top of the "x"s to show the shape of the data. A typical example is illustrated below.



Discuss the class data. Note any major differences among and similarities to the rest of the school survey data.

Activity 4: From Line Plots to Bar Graphs

You may wish to illustrate the various types of graphs using BLMs 10 and 11.

Communication

Representing Data

Ask *What is another way that we might graph the data?* Some students will propose that they construct a more formal graph, such as a bar graph. If available, illustrate different kinds of graphs from newspapers or magazines. Focus on bar, line, and circle graphs, discussing the uses for each type of graph. For example,

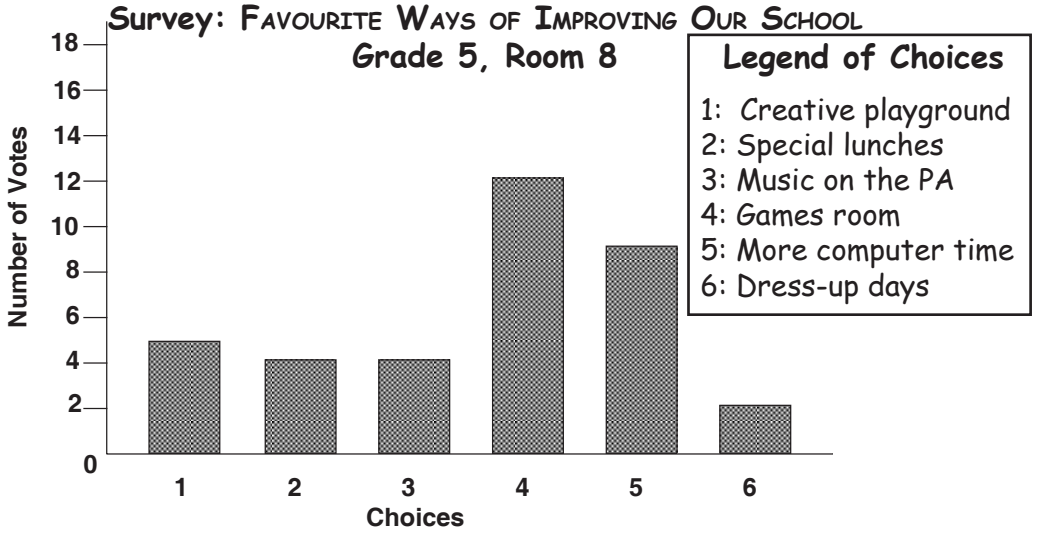
- **line graphs** frequently measure one thing over time (e.g., temperature);
- **bar graphs** often show comparison of different things (e.g., the quantity purchased of 4 different kinds of juice sold in the school), and
- **circle graphs** ("pie charts") show parts of a whole (e.g., the portion of the class who prefer one of four favourite sports).

Bar Graphs

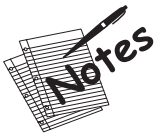
Ask *Which of these graphs would best represent the kind of data that we have collected?* In this case, the bar graph is probably the most suitable. Discuss the components of a bar graph, which include:

- a title (sometimes with the date);
- labels for both the horizontal axis and the vertical axis;
- scale or categories on both axes;
- a legend (if required);
- colour (optional).

Model the construction of a bar graph for the students. Consider using the data just collected from the class. This data will be meaningful, and, because it is limited, will make the scale on the vertical axis easier to calibrate (e.g., using graduation by 2s rather than 5s or 10s). Before you begin, ask students to consider if there are other ways to arrange the data (e.g., could the data be sorted, then represented from least to greatest number of votes? What implications would this have for the labels on the horizontal axis?) Indicate how to use the completed line plot as a guide to the construction of the bar graph. For example,



Activity 4: From Line Plots to Bar Graphs



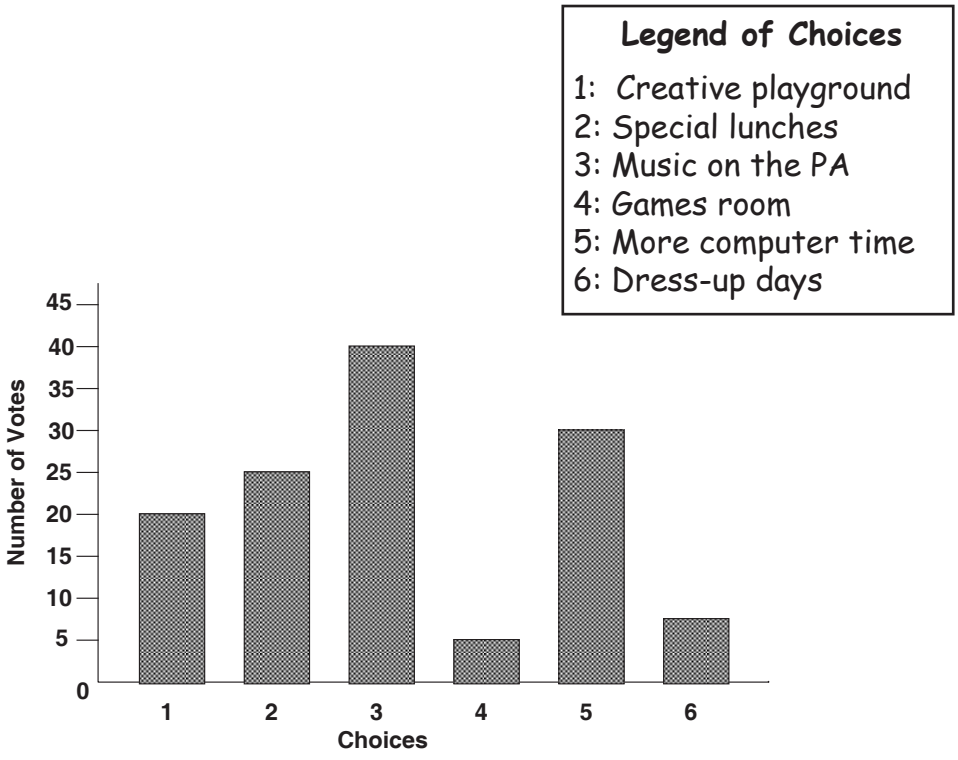
Have the students reflect on the data from BLM 4. Using carefully chosen questions, help them to develop a description of the data. For example;

- *Which choice received the least/greatest number of votes?*
- *Did any of the choices receive the same number of votes?*
- *What patterns do you see in the data? (i.e., Why do you think one class would give 2 votes for the choice "Music on the PA", while another class gave it 14 votes?)*
- *Did any of the groups vote in very similar ways?*
- *Do any of the results surprise you?*
- *Did primary students vote in a significantly different way from junior students?*

Have each student construct a bar graph representing the survey data on BLM 4 from the "Grand Total" column. It may be prudent to ask one person in each group to construct a line plot quickly. This will help to determine the general shape of the data, and will act as a guide in the construction of the bar graph. Challenge the students to determine a reasonable scale to be used on the vertical axis, based on the total number of votes. For example, the graph below reflects data totals that do not exceed 40 votes.

Problem Solving

Survey: Favourite Ways of Improving Our School



If more time is required, consider asking students to complete the graph for homework.

Use of Technology

Problem Solving

Extensions in Mathematics

1. Students who have access to appropriate software (e.g. Clarisworks™) may wish to develop a bar graph using a computer.

Cross-Curricular Activities

1. Often a graph can convey information more clearly than words alone. Have students suggest such types of data from other subject areas. Students could be asked to write their reasons for believing a graph would be clearer.

Family Activity

1. Students could construct a bar graph to illustrate data collected from their families (see Activity 1)
2. Students and family members could collect data from the neighbourhood showing different types of buildings on their block (e.g. apartments, stores, houses, garages) and illustrate a bar graph.

Other Resources

For further details, see annotated Other Resources list on page 41, numbered as below.

1. "Making Sense of Data", addenda series, Grades 5 - 8

8. *Mathematics Teaching In The Middle School*, March 1999, Focus Issue on "Data and Chance", NCTM

Activity 5: From Data to Action

Focus of Activity

- Analysis and description of survey data in different ways, using appropriate mathematical language

What to Assess

- Use of mathematical language
- Ability to analyze and write about survey data in a meaningful way
- Ability to construct a bar graph suitable for the data
- Collaboration with other members of the survey team

Preparation

- Retrieve the existing overhead transparency of BLM 4.
- Make a copy of BLM 7 for each student.
- Provide a calculator for each survey group (optional).
- Make a copy of BLM 8 for each group (optional).

Activity

Mathematical Language

Use completed overhead of BLM 4. Ask students to refer to their own team copies. Calculate and record the vertical totals to determine the number of votes cast in each class.

Explore the use of these numbers using comparative and descriptive mathematical language in such statements as

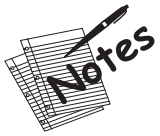
"9 out of 31 students in Class #6 liked choice 3 the best"
"More than half the students in Class #2 chose special lunches."
"Only 2 out of 33 in class #3 chose creative playgrounds or dress-up days."

Write the first few words of these or similar statements using the available data (e.g. "9 out of 31...", "More than half..."). Challenge the students to complete each statement, in more than one way if possible.

Writing About the Data

Have each group use the data collected from its own survey to construct a bar graph. Have the students, in their survey groups, write 3 statements, similar to the ones above, about the data they collected. Encourage them to vary the format of the sentences, and to focus on the elements in the data that they feel are particularly significant.

(Optional) If time permits, have each group present the first few words of their statements to the class, as described above. Class members use their copies of BLM 4 to complete each sentence. Discuss the accuracy and value of each statement. (Alternatively, have statements posted on the bulletin board with the ends of the sentences folded back. Other students examine the data, complete each statement mentally or orally, and unfold the paper to compare with the original statements.)



You may wish, during or after this discussion of Mathematical Language, to review some mathematical terminology. For example, in Class #6, $\frac{9}{31}$ of the students liked choice 3 the best. The denominator represents the total number of votes by the whole class, and the numerator represents the number of votes cast for choice #3.

Communication

Problem Solving

You may also wish to have students determine percents of votes cast, using a calculator. For example, "More than 50% of Class #4 chose special lunches or music on the PA."

Communication

Assessment

Have each survey group compose a thank-you letter to the class that they surveyed. The letter should incorporate the following:

- a thank-you for permitting them to use the class;
- important aspects of the survey data for that class (including the type of statements described above);
- any aspects of the combined data that they feel are important;
- an offer to visit the class to answer questions about the survey.

As a summary activity, have students record their personal insights into the survey using BLM 7. Consider including the journal entry and a completed graph in each student's mathematics portfolio.

Extensions in Mathematics

1. Invite students to develop their own surveys, selecting topics that are of interest to them. Provide copies of BLM 8 to help students in the planning process.

2. Count the numbers for the choices for each rating, and group them using a classification system. For example, ratings of 0 - 3 are *low*, 4 - 6 are *moderate*, 7 - 10 are *high*. Construct a bar graph to illustrate this system. Does this new bar graph convey more or less information then your original bar graph? Why?

Communication

Cross-Curricular Activity

1. Ask *Who would be interested in this data?* For example, parents, trustees, taxpayers, and students would be interested in the rating results. Companies making and selling playground equipment, safety officers, city planning officials, neighbours, fast food outlets, and parents of children who have food allergies would be interested in particular choices. Have students pick one of these groups and write a letter to them, perhaps to request information about their product, (e.g. playground equipment, or special lunches), using the data to justify their request.

Family Activity

1. Have students discuss the results of BLM 4 with their families, and try to answer the following question: *How might the results of this survey be different in another school? in another part of the city? in another province? in another part of the country? in another part of the world?*

Other Resources

For further details, see annotated Other Resources list on page 41, numbered as below.

3. "Developing Graph Comprehension: Elementary and Middle school Activities", by Frances R. Curcio

BLM 1: Rating Scale

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

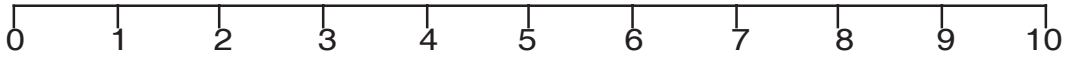
0 1 2 3 4 5 6 7 8 9 10

How do you rate our school?

0 1 2 3 4 5 6 7 8 9 10

BLM 2: Analysing the Data

1. Using the data collected in your classroom, complete the Line Plot showing how your class rates your school



2. Use these questions to help guide your thinking about the results.

   (a) What does the graph tell you?

   (b) How do most people feel about our school?

   (c) Why do you think you got the results you did?

   (d) Was any of the information unexpected? If so, what? Why?

   (e) How would you describe the "shape" of the data?

BLM 3: Survey

Survey Data for _____
(Name of sample group)

Choices	Total
1. _____	
2. _____	
3. _____	
4. _____	
5. _____	
6. _____	

Rating Scale Data

Scale	Number of Votes
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

BLM 4: Combined Data on Choices

Choices	Survey Group #	Survey Group #	Survey Group #	Survey Group #	Survey Group #	Survey Group #	Total Number Outside Votes	Our Classroom	Grand Total
1.									
2.									
3.									
4.									
5.									
6.									
Class Totals									

BLM 5: Let's Make Our School a Ten!

List below your ideas for improving attitudes towards your school. Include any additional ideas from your family and friends.

BLM 6: The Interview Process

Here are some suggested steps to be used in conducting the survey:

a) State the general purpose of the survey.

b) Describe the two types of data being collected:
   i) rating scale

   ii) opinions on choices

c) Give a rating scale to each person, asking students to circle the number which best reflects their feelings about the school.

d) Collect the competed rating scales

e) Read the list of the 6 top choices for improvement

f) Vote by a show of hands. (One vote per person only!)

g) Record the results directly on the Survey BLM 2.

My Survey

a) Purpose

b) Descriptions:

i)

ii)

c) How I will distribute the rating scale:

d) How I will collect the rating scales:

e) How I will explain these if necessary:

f) Who will count hands? How I will make sure nobody votes twice?

BLM 7: Journal Organizer: "Ways of Improving Our School"

Name: _____

1. Record the number of classes surveyed for each grade.

K _____	3 _____	6 _____
1 _____	4 _____	7 _____
2 _____	5 _____	8 _____

2. Which choice received the most votes? _____

3. Which choice received the fewest votes? _____
_

4. Did any of the groups or grades vote in similar ways?
Explain why you think they did or did not.

_____

_____

_____

5. Do any of the results surprise you?

_____

_____

_____

6. What math skills have you learned or used during your work on this data management unit?

_____

_____

_____

7. Explain why people use graphs to display data or information.

_____

_____

_____

BLM 8: Developing a Survey and Presenting the Data

Name: _____

My Survey Topic: _____

Possible CHOICES on my survey:

a) _____

b) _____

c) _____

d) _____

1. What do I predict will be the most popular choice? _____

2. Who will I survey? (age, grade, gender) _____

_____

Number of people I will survey: _____

3. What kind of graph will I use to represent my data? Why?

_____

_____

4. Will the data be shown as number of votes or percentages?_____

5. What information will go along the horizontal axis?

_____

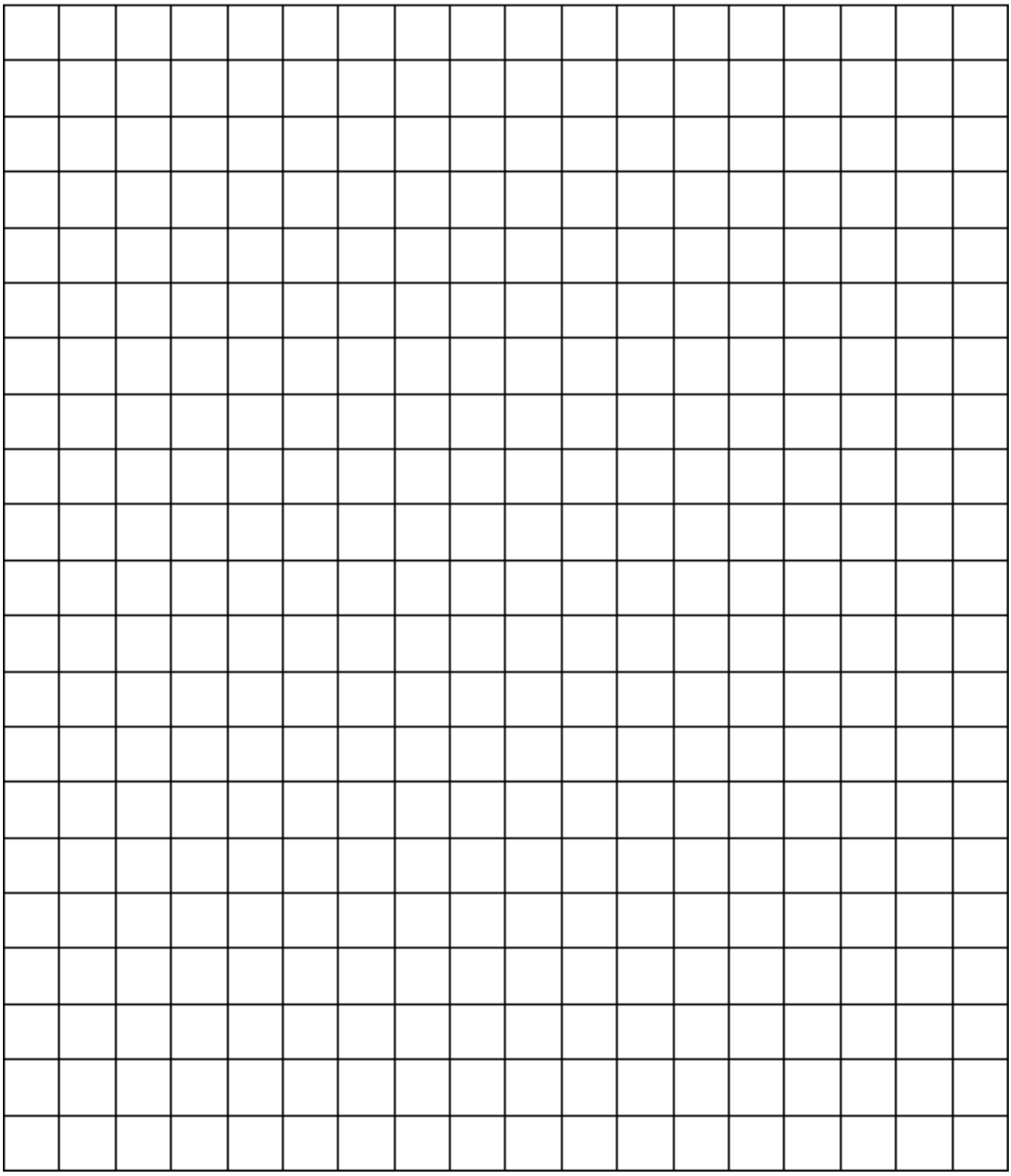
6. What information will go along the vertical axis?

_____

7. What will be the title of the graph?

_____

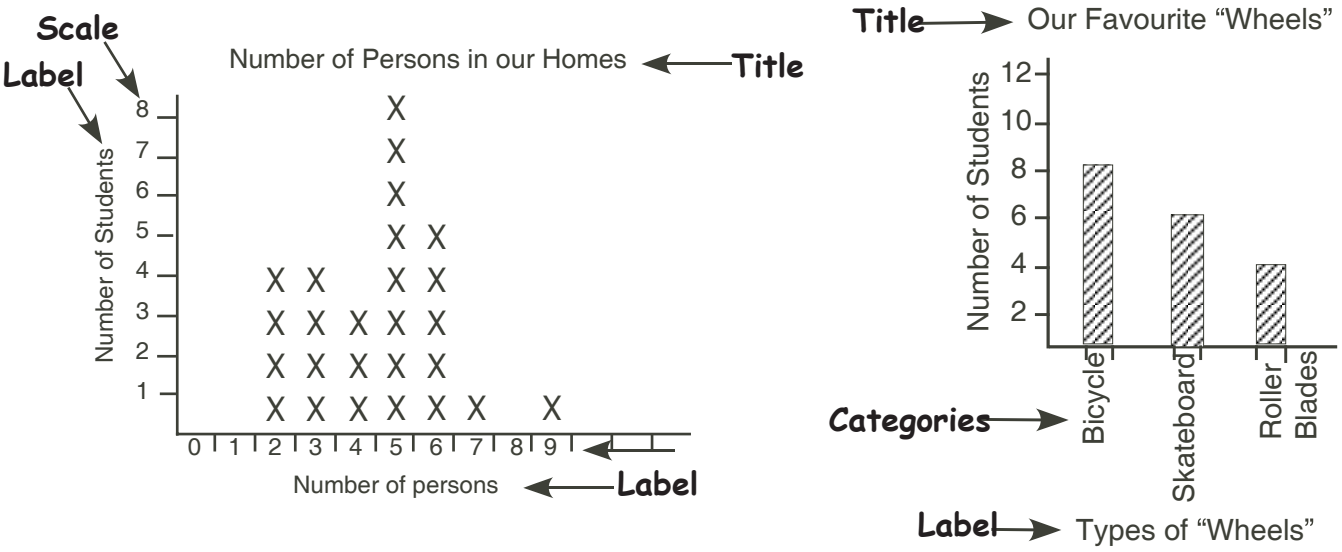
BLM 9: 1 cm Grid Paper



BLM 10: Sample Graphs - 1

Several types of graphs, with their components identified, are given here.

BAR GRAPH



Bar graphs may be constructed with bars or with repeating elements as shown.

Each axis should have a label or title. Axes should also have scales (see first graph) or lists of categories (see second graph).

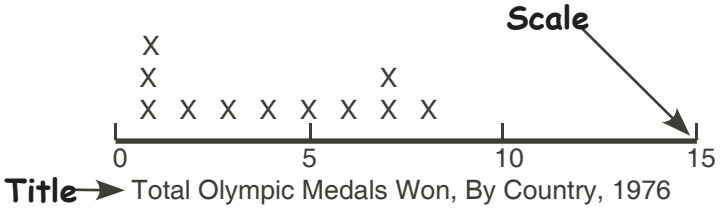
Each graph has a title.

Usually there are spaces between the bars.

Bar graphs are used to compare items with each other.

LINE PLOT

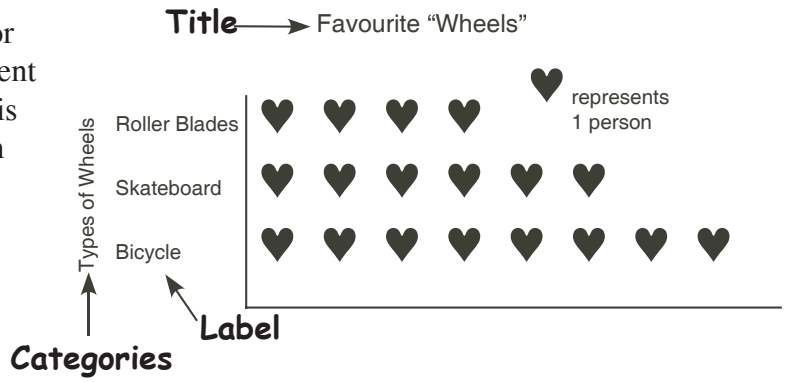
The Line Plot is a very simple type of graph and is useful when comparing bits of data. However, the line plot does not indicate who (or, in the example shown, what country) each piece of data represents.



BLM 11: Sample Graphs - 2

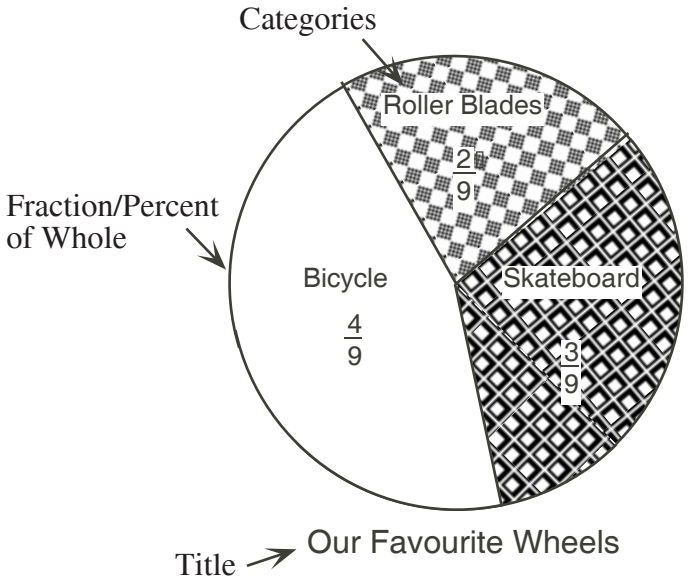
PICTO-GRAPH

A picto-graph is very like a bar graph, The major difference is the legend. One symbol may represent one person, as here, or any number of people. It is therefore useful when graphing a set of data with large numbers (e.g., populations of countries)



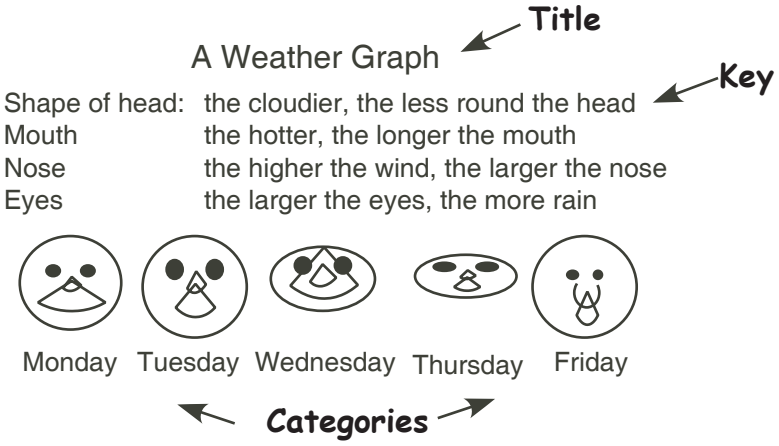
CIRCLE GRAPH

A circle graph is used to illustrate parts of a whole, in this case a whole class. Circle graphs are not appropriate for things like daily temperature for which there is no "whole".



'GLYPH' GRAPH

While not a traditional graph, graphs such as the one shown can be used to present several types of data, while giving students the opportunity to analyse data, which they must do in order to devise a workable "key".



Suggested Assessment Strategies

Investigations

Investigations involve explorations of mathematical questions that may be related to other subject areas. Investigations deal with problem posing as well as problem solving. Investigations give information about a student's ability to:

- identify and define a problem;
- make a plan;
- create and interpret strategies;
- collect and record needed information;
- organize information and look for patterns;
- persist, looking for more information if needed;
- discuss, review, revise, and explain results.

Journals

A journal is a personal, written expression of thoughts. Students express ideas and feelings, ask questions, draw diagrams and graphs, explain processes used in solving problems, report on investigations, and respond to open-ended questions. When students record their ideas in math journals, they often:

- formulate, organize, internalize, and evaluate concepts about mathematics;
- clarify their thinking about mathematical concepts, processes, or questions;
- identify their own strengths, weaknesses, and interests in mathematics;
- reflect on new learning about mathematics;
- use the language of mathematics to describe their learning.

Observations

Research has consistently shown that the most reliable method of evaluation is the ongoing, in-class observation of students by teachers. Students should be observed as they work individually and in groups. Systematic, ongoing observation gives information about students':

- attitudes towards mathematics;
- feelings about themselves as learners of mathematics;
- specific areas of strength and weakness;
- preferred learning styles;
- areas of interest;
- work habits — individual and collaborative;
- social development;
- development of mathematics language and concepts.

In order to ensure that the observations are focused and systematic, a teacher may use checklists, a set of questions, and/or a journal as a guide. Teachers should develop a realistic plan for observing students. Such a plan might include opportunities to:

- observe a small number of students each day;
- focus on one or two aspects of development at a time.

Suggested Assessment Strategies

Student Self-Assessment

Student self-assessment promotes the development of metacognitive ability (the ability to reflect critically on one's own reasoning). It also assists students to take ownership of their learning, and become independent thinkers. Self-assessment can be done following a co-operative activity or project using a questionnaire which asks how well the group worked together. Students can evaluate comments about their work samples or daily journal writing. Teachers can use student self-assessments to determine whether:

- there is change and growth in the student's attitudes, mathematics understanding, and achievement;
- a student's beliefs about his or her performance correspond to his/her actual performance;
- the student and the teacher have similar expectations and criteria for evaluation.

Resources for Assessment

1. The Ontario Curriculum Grades 1-8: Mathematics, Ministry of Education and Training, 1997.

2. "Linking Assessment and Instruction in Mathematics: Junior Grades" by OAME/OMCA, Crompton et al, 1996.
   The document provides a selection of open-ended problems tested in grades 4, 5, and 6. Performance Rubrics are used to assess student responses (which are included) at four different levels. Problems could be adapted for use at the Junior Level. Order from OAME/AOEM, P.O. Box 96, Rosseau, Ont., P0C 1J0. Phone/Fax 705-732-1990.

3. "Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions", by Jean Karr Stenmark (Ed.), NCTM, 1991.
   This book contains a variety of assessment techniques and gives samples of student work at different levels. Order from Frances Schatz, 56 Oxford Street, Kitchener, Ont., N2H 4R7. Phone 519-578-5948; Fax 519-578-5144. email: frances.schatz@sympatico.ca

4. "Assessment", Arithmetic Teacher Focus Issue, February 1992, NCTM.
   This copy of NCTM's journal for elementary school addresses several issues dealing with assessment. It also includes suggested techniques and student activities.

5. "How to Evaluate Progress in Problem Solving", by Randall Charles et al., NCTM, 1987.
   Suggestions for holistic scoring of problem solutions include examples of student work. Also given are ways to vary the wording of problems to increase/decrease the challenge. A section on the use of multiple choice test items shows how these, when carefully worded, can be used to assess student work.

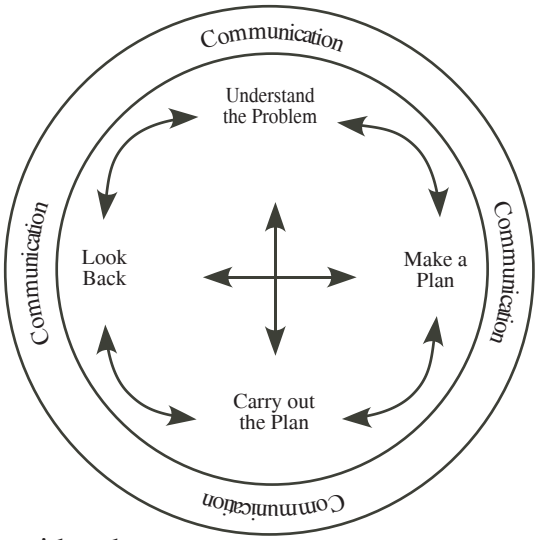
A GENERAL PROBLEM SOLVING RUBRIC

This problem solving rubric uses ideas taken from several sources. The relevant documents are listed at the end of this section.

"US and the 3 R's"

There are five criteria by which each response is judged:
Understanding of the problem,
Strategies chosen and used,
Reasoning during the process of solving the problem,
Reflection or looking back at both the solution and the solving, and
Relevance whereby the student shows how the problem may be applied to other problems, whether in mathematics, other subjects, or outside school.

Although these criteria can be described as if they were isolated from each other, in fact there are many overlaps. Just as communication skills of one sort or another occur during every step of problem solving, so also reflection does not occur only after the problem is solved, but at several points during the solution. Similarly, reasoning occurs from the selection and application of strategies to the analysis of the final solution. We have tried to construct the chart to indicate some overlap of the various criteria (shaded areas), but, in fact, a great deal more overlap occurs than can be shown. The circular diagram that follows (from OAJE/OAME/OMCA "Linking Assessment and Instruction in Mathematics", page 4) should be kept in mind at all times.



There are four levels of response considered:

Limited identifies students who are in need of much assistance;

Acceptable identifies students who are beginning to understand what is meant by 'problem solving', and who are learning to think about their own thinking but frequently need reminders or hints during the process.

Capable students may occasionally need assistance, but show more confidence and can work well alone or in a group.

Proficient students exhibit or exceed all the positive attributes of the **Capable** student; these are the students who work independently and may pose other problems similar to the one given, and solve or attempt to solve these others.

Suggested Assessment Strategies

CRITERIA FOR ASSESSMENT

LEVEL OF RESPONSE →

	Limited	Acceptable	Capable	Proficient
UNDERSTANDING	• requires teacher assistance to interpret the problem • fails to recognize all essential elements of the task	• shows partial understanding of the problem but may need assistance in clarifying	• shows a complete understanding of the problem	• shows a complete understanding of the problem
STRATEGIES	• needs assistance to choose an appropriate strategy	• identifies an appropriate strategy	• identifies an appropriate strategy	• identifies more than one appropriate strategy
	• applies strategies randomly or incorrectly • does not show clear understanding of a strategy[1] • shows no evidence of attempting other strategies	• attempts an appropriate strategy, but may not complete it correctly[2] • tries alternate strategies with prompting	• uses strategies effectively • may attempt an inappropriate strategy, but eventually discards it and tries another without prompting	• chooses and uses strategies effectively[3] • recognizes an inappropriate strategy quickly and attempts others without prompting
REASONING	• makes major mathematical errors • uses faulty reasoning and draws incorrect conclusions • may not complete a solution	• may present a solution that is partially incorrect	• produces a correct and complete solution, possibly with minor errors	• produces a correct and complete solution, and may offer alternative methods of solution
	• describes[4] reasoning in a disorganized fashion, even with assistance • has difficulty justifying[5] reasoning even with assistance	• partially describes[4] a solution and/or reasoning or explains fully with assistance • justification[5] of solution may be inaccurate, incomplete or incorrect	• is able to describe[4] clearly the steps in reasoning; may need assistance with mathematical language • can justify[5] reasoning if asked; may need assistance with language	• explains reasoning in clear and coherent mathematical language • justifies[5] reasoning using appropriate mathematical language
REFLECTION	• shows no evidence of reflection or checking of work • can judge the reasonableness of a solution only with assistance	• shows little evidence of reflection or checking of work • is able to decide whether or not a result is reasonable when prompted to do so	• shows some evidence of reflection and checking of work • indicates whether the result is reasonable, but not necessarily why	• shows ample evidence of reflection and thorough checking of work • tells whether or not a result is reasonable, and why
RELEVANCE	• unable to identify similar[6] problems	• unable to identify similar[6] problems	• identifies similar[6] problems with prompting	• identifies similar[6] problems, and may even do so before solving the problem
	• unlikely to identify extensions[7] or applications of the mathematical ideas in the given problem, even with assistance	• recognizes extensions[7] or applications with prompting	• can suggest at least one extension[7], variation, or application of the given problem if asked	• suggests extensions[7], variation, or applications of the given problem independently

Notes on the Rubric

1. For example, diagrams, if used, tend to be inaccurate and/or incorrectly used.

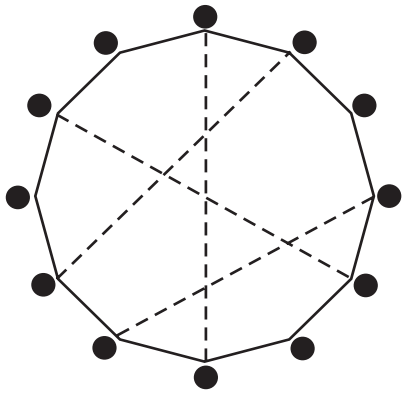
2. For example, diagrams or tables may be produced but not used in the solution.

3. For example, diagrams, if used, will be accurate models of the problem.

4. To *describe* a solution is to tell *what* was done.

5. To *justify* a solution is to tell *why* certain things were done.

6. *Similar* problems are those that have similar structures, mathematically, and hence could be solved using the same techniques.
   For example, of the three problems shown below right, the better problem solver will recognize the similarity in structure between Problems 1 and 3. One way to illustrate this is to show how both of these could be modelled with the same diagram:



Problem 1: There were 8 people at a party. If each person shook hands once with each other person, how many handshakes would there be? How many handshakes would there be with 12 people? With 50?

Problem 2: Luis invited 8 people to his party. He wanted to have 3 cookies for each person present. How many cookies did he need?

Problem 3: How many diagonals does a 12-sided polygon have?

   Each dot represents one of 12 people and each dotted line represents either a handshake between two people (Problem 1, second question) or a diagonal (Problem 3).

   The weaker problem solver is likely to suggest that Problems 1 and 2 are similar since both discuss parties and mention 8 people. In fact, these problems are alike only in the most superficial sense.

7. One type of extension or variation is a "what if...?" problem, such as "What if the question were reversed?", "What if we had other data?", "What if we were to show the data on a different type of graph?".

Suggested Assessment Strategies

Adapting the Rubric

The problem solving in this unit is spread throughout the activities. That is, not all the components of problem solving as outlined in the rubric are present in each lesson. However, there are examples of each to be found in the series of activities presented.

Examples of these criteria are given below with questions based on a part of one of the activities. This allows you to assess the students' problem-solving abilities in different ways at different times during the unit.

You may wish to share this type of assessment with students. The more aware of the nature of problem solving (as "described" by a rubric) they become, the better problem solvers they will become, and the more willing to try to articulate their solutions and reasons for their choices of various strategies and heuristics.

Activity 1

UNDERSTANDING: How well do students understand and interpret a simple line plot?

For example,

- The "Limited" student may have difficulty identifying one "X" on the line plot with one vote on the rating scale, and may be confused by the two sets of figures in the table shown in the activity notes and one set of figures on the rating scale.

- The "Acceptable" student will be able to explain how the "X"s on the line plot are related to the votes on the rating scale, but may need the completion of the line plot to understand this.

- The "Proficient" student will be able to predict, from the table, the appearance of the line plot after only a few points have been plotted.

Activity 2

UNDERSTANDING: How well do students recognize the need for a good survey instrument if the data collected are to be useful?

For example,

- The "Acceptable" student understands that there is some connection between a questionnaire and the data collected, but may not see that a poor question might lead to the collection of data that are not relevant.

- The "Capable" student understands that the data collected depend on the clarity of the questions asked, but may not be able to re-word successfully questions he/she knows are poor.

Suggested Assessment Strategies

REASONING: How reasonably do students predict the results of surveying other groups using the rating scale?

For example,

- The "Acceptable" student gives a reason for his/her prediction, but is not capable of justifying the prediction. He/she may simply say, "I think grade one children will say that they like the school. I liked it in grade one."

- The "Proficient" student can justify predictions by such statements as "I think grade one students will rank the school as very high because it is probably their first school, and they do a lot of things in grade one that kids like to do."

Activity 3

REFLECTION: How well do students evaluate earlier predictions in light of the data they actually collected?

For example,

- The "Limited" student may simply note that he/she was "right" or "wrong" in his/her prediction.

- The "Proficient" student will be able to suggest a reason why there is a discrepancy between his/her prediction and the data collected. For example, "I think the grade two kids thought they were supposed to be telling me whether or not they liked going to school, not how they ranked the school. Perhaps if I had given them some examples, the question might have been clearer."

Activity 4

REASONING: How well did students justify the type of graph chosen to illustrate the data? Do they recognize that a line graph would not be suitable, and why? Do they recognize that bar graphs are useful for comparing pieces of data?

Activity 5

REASONING: When students write about their graphs, do they use mathematical language? Do their statements reflect their graphs accurately? How well can they justify the statements to their classmates?

RELEVANCE: How well do students understand that collecting data and illustrating it with a graph are skills that are used in many jobs, and in many subjects they may study? How well can they interpret graphs used in geography or science or graphs found in advertisements or stock market reports?

For example,

- The "Acceptable" student can locate graphs, if asked, in other subject text books and in newspapers, and can identify the topic of the graph, but may still not see any value in being able to construct or interpret graphs.

- The "Proficient" student shows his/her awareness of the widespread use of graphs and can describe graphs he/she has seen elsewhere, and can discuss them knowledgeably.

Other Resources

1. "Making Sense of Data: Addenda Series, Grades K-6", by Mary Lindquist et al., NCTM, 1992.
   Activities for each grade are presented with lesson outlines and selected black line masters.
   Students collect,represent and analyze data.

2. "Dealing with Data and Chance: Addenda Series, Grades 5-8", by Judith S. Zawojewski et al., NCTM, 1991.
   Data gathering and reasoning are two of the themes of this book. Ways people use data and chance in their everyday lives are also discussed.

3. "Developing Graph Comprehension: Elementary and Middle School Activities", by Frances R. Curcio, NCTM, 1989.
   The book contains 25 activities for classroom use dealing with interpreting and constructing various types of graphs.

4. "Using a Database for Student Research", by Lulu Healey and Celia Hoyles, *Mathematics Teaching in the Middle School,* NCTM, January 1997, pages 154-158.
   The article describes a special project for 10- and 11-year-olds in which they attempted to collect valid data on possible sexism in story books in the school.

5. "Ideas", by Joan Westley, *Arithmetic Teacher*, NCTM, February 1991, pages 30-36.
   Students use balloons to collect data for a variety of graphs from sources of free balloons to lung capacity. Students pages are available for copying, and a letter for parents/caregivers is included.

6. " Consumer Investigations: What Is The 'Best Chip'". by Dixie Methany, *Teaching Children Mathematics*, NCTM, March 2001, Pages 418 - 420
   Students design surveys and collect data to determine favourites to compare crispiness and to identify calories per serving for several varities of chips (potatoe, salsa, corn, etc.). They write reports " for a consumer magazine" that include charts and graphs.

7. " Our Heritage: Learning Data - Management Skills Meaningfully," by Yvonne M. Pothier and Christine M. Nickerson, *Teaching Childred Mathematics*, NCTM, October 1997, pages 82 -88
   Students collect data about themselves and their families, such as 'my choice of occupation', 'toys I own', 'allowances my grandparents received', 'sports my grandparents played', and so on. Sample questionnaires are included.

8. "*Mathematics Teaching in the Middle School*", March 1999, Focus Issue on "Data and Chance", NCTM. The entire journal is devoted to articles dealing with Data Management & Probability. One article deals with students' TV watching. Another records data about peanut butter (cost per unit, saltiness, colour) and records data using line plots and stem - and - leaf plots.

9. "Power Over Trash", by Robert N. Ronau and Karen S. Karp, *Mathematics Teaching in the Middle School*, NCTM, September 2001, pages 26 - 31. Students collect garbage from school grounds and classify different types (paper, plastic, metal). They record this on "strip graphs" which are then looped into circles to help develop circle graphs. Some use graphing calculators (computer programs can also be used). Data was then compared with national data from landfill sites.

Other Resources

10. " Graphing in the Information Age: Using Data from the World Wide Web," by Juli K. Dixon and Christy J. Falba, *Mathematics Teaching in the Middle School*, NCTM, March - April 1997, pages 298 - 304. Ideas for activities include interpretation and creation of bar graphs, line graphs, and circle graphs. Examples of the type of data that can be found on the web are given (e.g., average earnings versus education, NHL stats, frequency of winning lotto numbers).

11. "Interdisciplinary Projects Enhance Teaching and Learning", by Jo Clay Olson, *Mathematics Teaching in the Middle School*, NCTM, January 2003, pages 260 - 266. Several projects that are cross-curricular are described. Language Arts and Geography, in particular, are involved as students design a country given area and perimeter, topology (e.g. 20% mountains), and other constraints. Students draw maps, build models, construct graphs, and write reports.

12. " Adventures in Statistics", by Thomas R. Scavo and Byron Petraroja, *Teaching Children Mathematics*, NCTM, March 1998, pages 394 - 400.
    Students collect and graph data on the length and width of classrooms and the number of students, then investigate the area per student in each classroom. Sample recording sheets are included.

13. "Gender, Ninja Turtles, and Pizza: Using a Classroom Database for Problem Solving", by Judith Day Siegel, *Teaching Children Mathematics,* NCTM, December 1996, pages 192-199.
    Students collect a wide range of classroom data as a database in Clarisworks™, and select various sets of data to illustrate with graphs.