

Project C: Planning for a Teen Recreation Centre

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Project C: Planning for a Teen Recreation Centre

Orientation

Time:

Phase I: Introduction 1 class period

Phase II: The Survey

Activity 1: Graphing 1 class period

Activity 2: Relating Statistical Variables 1 to 2 class periods

Activity 3: Linear Relationships 1 class period

Activity 4: Evaluation 1 class period

Phase III: Application

Activity 1: Application of Concepts to Community Needs 1 class period

Activity 2: The Plan 1 class period

Instructional Strategies:

- Case Study
- Field Study
- Group Work
- Issues Inquiry

Real-World Applications:

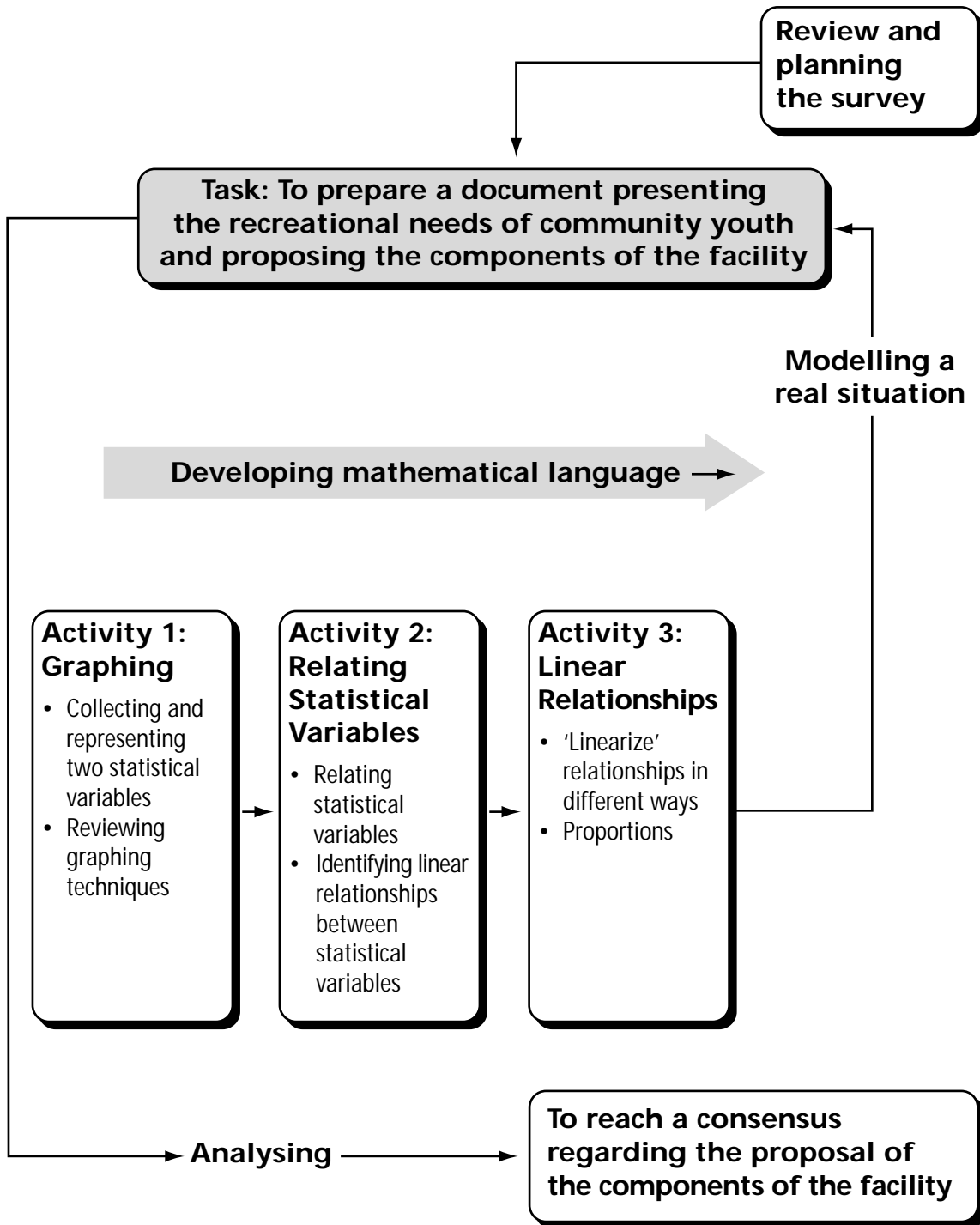
Some real-world applications of the skills and concepts learned in this project include:

- interpreting and analysing wildlife management and fisheries survey data
- judging the quality of survey questions
- interpreting and judging the results of a survey
- designing surveys and undertaking research

Project Overview:

Figure 1 on the following page is a schematic to help you conceptualize Project C, Planning for a Teen Recreation Centre.

Figure 1: Project C: Planning for a Teen Recreation Centre



Project Synopsis

In this project, students prepare a document presenting the recreational, cultural, and physical needs of youth that can be met through a teen community recreation centre. The document is to include a description of the components of the facility and their relative location.

In this project groups of students investigate the relationship, if any, between two variables related to the use of a recreational facility; create and interpret scatterplots; and draw appropriate conclusions relating to the planning of a multi-use facility.

This project can be done as a self-contained project or it can be used as the starting point for a much larger project that would incorporate Project D: Drawing a Scale Map for a Teen Recreation Centre and Project E: Building a Scale Model for a Teen Recreation Centre.

In either case, students are expected to design a survey, collect and present survey data, analyse the results, and make the appropriate recommendations regarding the facility.

This project begins with a set of concept development activities and then moves on to the application of these concepts for determining the factors that can affect the location and the components of the facility.

During the concept development activities, students analyse sets of experimental data in terms of two variables using a graphing calculator (if available) and determine if there is a correlation between the two variables.

Students are then expected to collect their own data from the community and apply their knowledge to determine and represent eventual relationships from scatterplots in order to prepare a rigorous analysis.

Phase I of this project gives the teacher an opportunity to present the project, stress its relevance in other fields of human activity, and let students know what is expected of them. The students and teacher prepare a plan of action where the steps are identified and reasons for them are given. The class is divided into groups and the teacher assigns tasks to each group.

The teacher should determine whether a review is necessary. The areas to be reviewed may include: methods of collecting information, data presentation using a graph, and analysis of statistical data. Some students may also need to review how to use their calculator to perform statistical calculations and draw graphs.

In Phase II students use the survey as a data collection method. They determine relationships between two variables from the examination of scatterplots, and explore linear, non-linear, and random relationships.

In Phase III, students develop a plan based on survey results and their analyses. Students are asked to reach a consensus on the location of the facility and on the different components including swimming pool, library and theatre. They

identify and explore the relevant mathematical concepts they would need in order to prepare and submit a professional-looking proposal to the proper authorities.

Mathematical concepts developed in projects D and E are given below.

- In Project D, Drawing a Scale Map for a Teen Recreation Centre, students are introduced to triangulating techniques in surveying. They prepare a scale map from actual measurements.
- In Project E, Building a Scale Model for a Teen Recreation Centre, students develop and apply their spatial abilities to solve construction problems. They construct three-dimensional models from plans.

Phase 1: Introduction

Objective:

In this phase, students formulate a picture of the recreational needs of youth in their community. To make this picture as accurate as possible, students need to determine if there are relationships between youth activities and other variables such as their age, gender, the distance to existing facilities from their home, and the time required to travel.

Students also need to determine the extent to which their habits would change if a new facility was to meet their needs through better accessibility, and particular components of a teen recreation centre.

In order to investigate these relationships accurately, students explore scatterplots and lines of best fit by inspection and, if available, by using a graphing calculator.

Note: Before you begin this project, check with your school administrator to determine whether there is any school or district policy of which you need to be aware regarding students conducting or participating in surveys.

Materials:

- graphing calculator
- computer with graphing software

Procedure:

Introduce the project and stress its relevance and importance in other fields of human activity. Inviting a city councillor, a survey analyst, an insurance consultant, or a police officer to speak to your class can provide students with information about real-world applications for the mathematics they are studying.

Informally evaluate the current mathematical knowledge of your students and prepare a review if necessary. This review may include the following:

- the concept of population and sample (what is the population to be surveyed and what would be an appropriate sampling method);
- how to formulate statistical questions clearly;
- how to use appropriate methods of collecting and displaying data; and
- how to identify bias in data collection and presentation.

Use examples to introduce the concept of a statistical relationship between two variables. Mention to students that they are going to explore this particular aspect of statistics. Select one example where two variables are strongly related and another example where they are not related.

Prepare an action plan with students, and indicate what is expected from them at the end of the current project. The action plan is to include:

- the steps involved including contacting schools, obtaining a list of students, deciding how to sample; and
- the type of interview to be used, for example personal or telephone.

In discussion with the students, decide:

- the survey outcomes
- those specific questions that are appropriate
- those community members who are appropriate to interview

Provide examples of questionnaires and surveys.

Divide the class into groups and assign specific tasks, that is one or two specific components of a teen recreation centre.

- Encourage students to prepare supplementary questions related to their topic. For example, if their topic is to investigate the need for a library, ask students to provide questions such as: “Are you currently using a library? How many times a week do you use the library?”
- Ask students to represent their results in the form of graphs before they proceed to the planning session.
- During the process of collecting and representing the results, students should be reminded to stay focussed on the purpose of this activity, that is, to form a picture of student needs related to a teen recreation facility.

Phase II: The Survey

Objective:

The objective of this phase is for students to explore the relationship between two statistical variables, and to learn ways of representing and interpreting data.

Procedure:

Distribute Student Activity: Graphing. Students use this activity to explore the relationship between two statistical variables by representing data obtained from various sources on a graph. Using Figure 2: Number of Accidents Versus Age Group, they analyse the relationship between the variables.

As an extension, students explore ways of creating a linear relation.

How do you decide if two events or situations are related? If so, how do you describe the way(s) in which they are related?

For example:

- What is the relation (if any) between age and car accidents, or age and number of speeding tickets?
- Is there a relation between the distance you live from a swimming pool and the number of times you use the pool, or that distance and the time required to travel to the pool?
- Is there a relation between the hour of the day and the water consumed in your house?
- Is there a relation between the number of hours you spend on the telephone and the size of your shoes?

Ask students to formulate questions for which they would like to find answers. Examples of these might include:

- Does the occurrence of accidents increase with age?
- Is there a particular age group in which there is a greater probability of having more than one accident in a year?

Then ask students to identify all of those variables they would need to consider in order to answer their question.

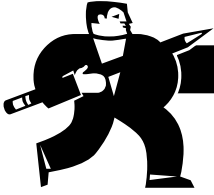
Students then plot their data as a graph by choosing the two variables.

Example of pairs of variables are:

- zero accidents and age group
- number of accidents in one year and the 40-49 age group
- total number of accidents and a particular age group

The students should informally describe the relationship between the two variables. For example, is one variable always increasing, not related, increasing regularly, increasing up to a certain point and then decreasing with respect to the second variable?

Ask students to use the same graph region to represent three different relations, each with two or more pairs of variables. Ask them to describe the relationships between the pairs of variables when three relations seem to follow the same pattern: increasing, reaching a peak, decreasing and increasing again



Student Activity: Graphing

Student Name: _____ Date: _____

Activity 1: Graphing

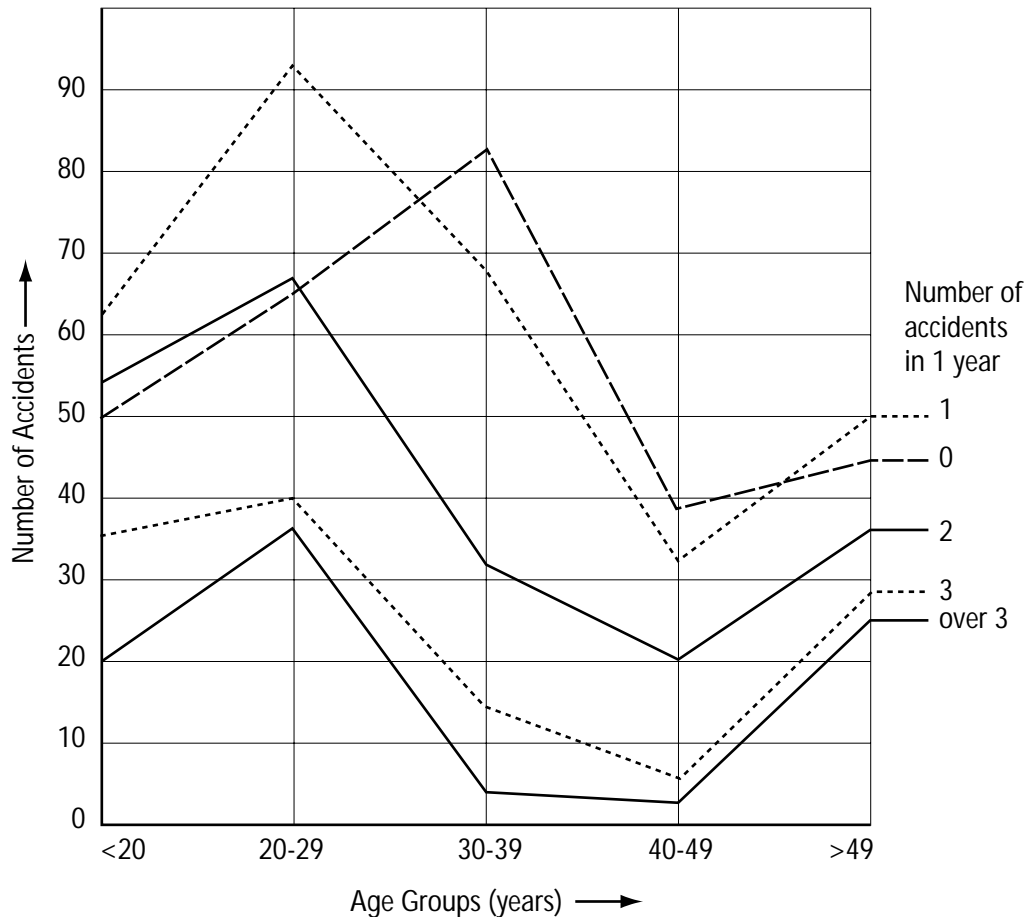
The following data are from an insurance company. One thousand drivers were selected at random in a particular city to determine if there was a relationship between age and number of accidents in a year.

Table 1

Relation Between Age Group and Accidents

Age	Accidents in 1 year				
	0	1	2	3	Over 3
Under 20	50	62	53	35	20
20-29	64	93	67	40	36
30-39	82	68	32	14	4
40-49	38	32	20	7	3
Over 49	43	50	35	28	24

Figure 2: Number of Accidents Versus Age Group



Ask students to answer the following:

- What is the probability for a driver chosen at random, of being under 20 years old and having 3 accidents in 1 year?

$$\text{answer: } \left(\frac{35}{1000} = 0.035 \right)$$

- of being 30-39 years old and having 1 or more accidents in 1 year?

$$\text{answer: } \left(\frac{68+32+14+4}{1000} = 0.118 \right)$$

- of having no accidents in 1 year?

$$\text{answer: } \left(\frac{50+64+82+38+43}{1000} = 0.277 \right)$$

- of being under 20 years old or having 3 accidents in 1 year?

$$\text{answer: } \left(\frac{53+62+50+35+20+40+14+7+28}{1000} = 0.309 \right)$$

In preparation for the next class, ask students to prepare a set of questions regarding car accidents for which they would like to obtain an answer. Students may be able to obtain statistics from ICBC, insurance companies, the RCMP, or their municipal police.

Some suggested questions are:

- Is it true that drivers are more likely to be involved in a car accident in the first six months after they obtain their driver's license than at any time later?
- What is the relationship between gender and the number of car accidents in a lifetime?
- Is it true that fewer red cars are involved in accidents than grey cars?
- What is the relationship between the number of accidents and the age of the car?
- What is the relationship between the number of speeding tickets and the age of the car?
- What is the relationship between the number of speeding tickets and the make of the car?
- What is the relationship between the number of speeding tickets and the age of the driver?
- What is the relationship between the number of speeding tickets and the gender of the driver?

Determine the extent to which students can:

- formulate problems clearly and concisely;
- select appropriate variables; and
- select proper sources of information.

Activity 2: Relating Statistical Variables

Objective:

The objective of this activity is to provide an opportunity for students to relate statistical variables and show these relationships graphically.

Materials:

- graphing calculator

Procedure:

Suggest to students that they design supplementary questions concerning two apparently unrelated variables (such as the number of speeding tickets versus car colour, or the number of accidents versus the date of the month).

Verify with your students that their questions have been formulated properly. If necessary, help students to reformulate them. The questions should address a specific situation involving two variables.

Give some examples of poorly formulated questions, for example, questions that:

- are too general
- have situations involving more than two variables
- have situations that are too specific with respect to the available information

Verify that students have collected the necessary information. If not, suggest that they make some reasonable guesses about what is missing.

Help students construct their graphs by suggesting what variable should be identified on the horizontal axis and what variable should be on the vertical axis.

Stress the fact that although the layout is sometimes not really important, almost always for presentation purposes it is better to position the graph in a particular way. As an example, for Figure 2: Number of Accidents Versus Age Group, explain that the researcher was seeking the number of accidents as a function of (dependent upon) the age groups rather than the reverse. The dependent variable is usually plotted on the vertical or y -axis.

Insist on the appropriate choice for the units represented on the axes. That is, the units selected should result in the data points occupying most of the space on the graph. Have students make a rough sketch of their graphs with pencil and paper in order to avoid surprises.

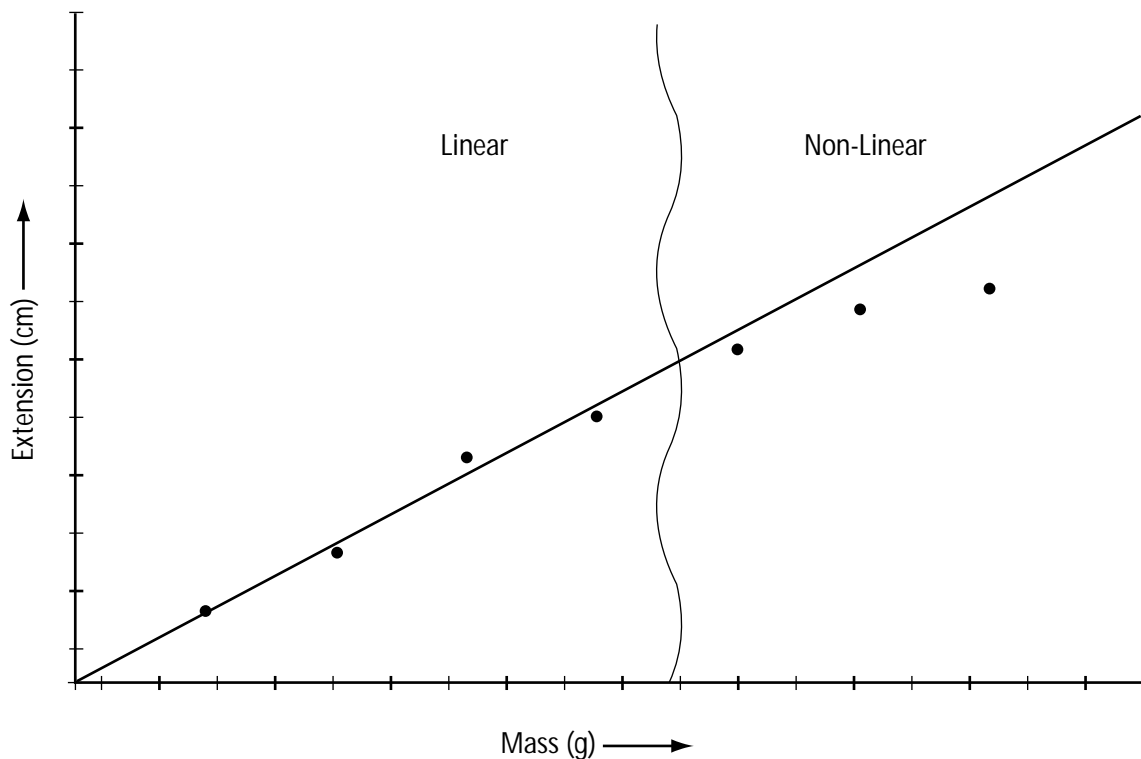
When their rough sketches are complete, ask them to informally describe the relationships between the variables (e.g., linear, no correlation, not constant, geometric) and then have them use a ruler, flexible ruler or snake to sketch the lines more accurately. Finally, have them draw the graphs with the help of a calculator or computer.

Have students determine the number for domains for the graph where the relation seems to be linear. Have students clearly identify the domains.

The teacher may consider the following activity to explore the linearity of a relation between two continuous variables:

- Have students measure the extension of a spring attached to various weights. This can be done by using an exerciser in the gym, a kit obtained from the physics lab, or a set of elastics attached to a support.
- Students measure the extension of the spring and complete Table 6: Springs. This information is then used to draw a graph.
- The vertical extension of the spring is plotted against the mass of the weights attached to the spring as in the graph shown in Figure 3: Elasticity of a Spring.
- Ask students to use a ruler to draw a line joining the points of the graph. They should then determine the domain where the relation seems to remain linear and the domain where the relation ceases being linear. A discontinuity may occur when the spring or the elastic is stretched too far.

Figure 3: Elasticity of a Spring



Activity 3: Linear Relationships

Objective:

The objective of this activity is to learn more about linear relationships between variables.

Materials:

- graphing calculator

Procedure:

In some cases, it is possible to demonstrate a linear relationship simply by changing the scale or by modifying one of the variables. An example of this is squaring one variable if the graph looks like a parabola such as that for a falling object.

Have students play with some graphs. By using their calculators and manipulating or changing scales such as squaring or taking the square root of one variable, they may be able to produce a linear graph or approximate one.

In other cases, students may use some techniques such as the median-median line or linear regression to demonstrate a linear relation.

The following example can help you introduce the median-median technique informally to your students:

- The Federal Department of Fisheries and Oceans has recorded the length and the mass of a sample of prawns fished in June 1998. The results are presented in Table 2: Length and Mass of Prawns.
- Distribute a copy of Table 2: Length and Mass of Prawns to the students and ask them to prepare a scatterplot as Figure 6: Prawns.
- Ask students to comment on any obvious relationships between the two variables. Then have them regroup the prawns into three categories based on mass: small, regular, and jumbo. Students need to decide upon the borders separating the three domains.
- Ask them to determine the average length and the average mass within each domain and to plot those results.
- Have students compare their regroupings with other students. As a class, have them decide the best regroupings in terms of the linearity of the line joining the three points of the graph.

Table 2

Length and Mass of Prawns

Length (cm)	Mass (g)	Length (cm)	Mass (g)
7.5	25.7	9.1	27.3
7.6	25.9	9.2	28.0
7.6	26.7	9.5	27.8
7.6	26.8	9.5	27.8
8	26.0	9.5	28.0
8	26.5	9.5	28.3
8	26.8	9.9	27.3
8	27.1	9.9	27.8
8.5	26.3	9.9	27.9
8.5	26.5	10	28.3
8.5	27.5	10.8	28.5
8.5	27.8	11	28.6
9	26.6	11.5	28.1
9	26.7	12	28.5
9	27.0	12	28.7
9	26.8	12.5	28.5
9.1	26.4	13	28.9

Introduce linear regression with the following example of data obtained from a bank. Table 3: Annual Savings and Annual Income compares annual savings with annual family income.

Table 3

Annual Savings and Annual Income

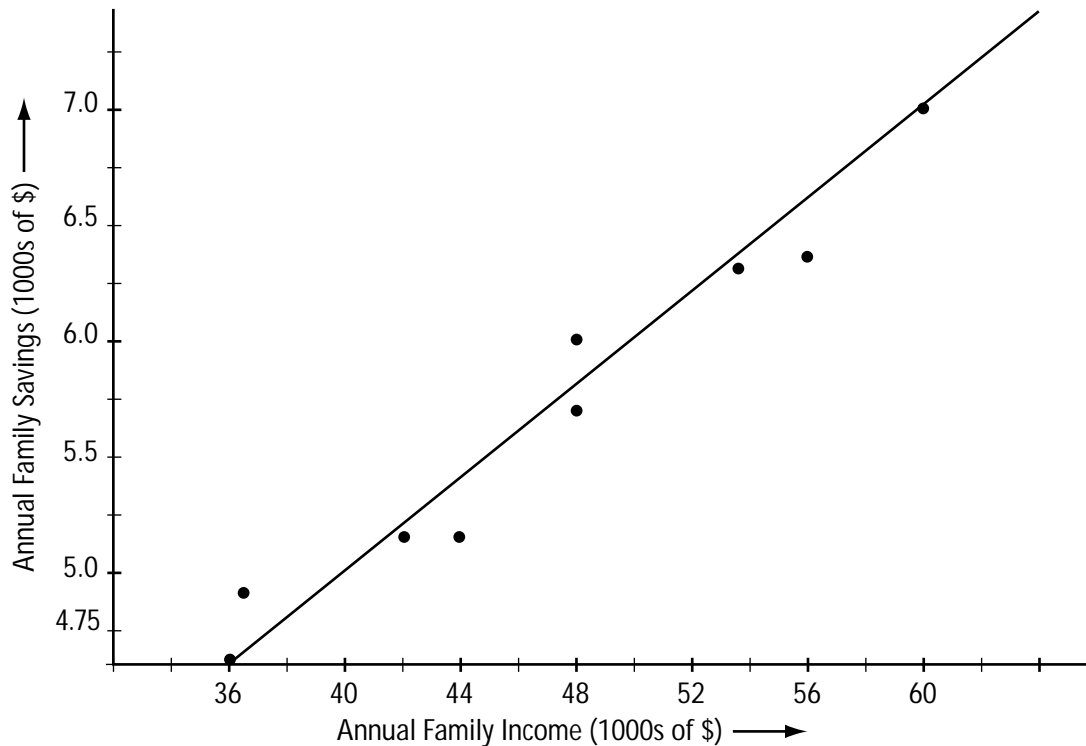
Annual Income (1000s of \$)	Annual Savings (1000s of \$)
42	5.2
48	6.0
36	4.6
56	6.3
60	7.1
54	6.3
44	5.2
48	5.7

Ask students to plot the data and guess the type of curve that would best fit the scatterplots. This curve should come as close as possible to all the points of the diagram. Suggest that they use a ruler and that they make sure that there are as many points to the right as there are to the left of the ruler's edge. Suggest that they try to 'weight' the distances between the points and the ruler.

The result has been calculated below by using a linear regression in Figure 4: Line of Best Fit Using Linear Regression.

Do not have students use their scientific calculators at this point because they are not able to understand the meaning of the equation of the regression line. It is, however, worthwhile to mention that there are systematic ways of evaluating the line of best fit.

Figure 4: Line of Best Fit Using Linear Regression



Students may collect data such as arm span versus shoe size or height versus arm span, using themselves and other students.

Have students perform the measurements and then have them prepare a graphical representation (plot the data and produce scatterplots).

Ask students to use Student Activity Figure 7: Generic Graph to record their measurements and prepare a graph.

Have students discuss the graph to determine the nature of the relationship — whether or not it is linear.

Have students regroup the scatterplot data in different ways and have them determine the median of each subgroup.

Have them plot the medians. This time the relationship may be more linear than it was originally.

Students should try different groupings until they obtain a model that can be considered linear.

Encourage students to use their calculators to perform these operations (most calculators can generate regression lines).

Activity 4: Evaluation

Objective:

The objective of this activity is to determine the extent to which students are able to:

- properly identify a given problem and the variables;
- accurately formulate the questions that are being addressed;
- collect appropriate data;
- prepare a table representing the data;
- construct a graph representing the data (graphs should include axes, units, points on the graph, and a title);
- correctly use a calculator or computer;
- identify the existence of any relationship between two variables;
- describe the relationship correctly and concisely;
- determine a linear domain, if applicable;
- propose ways of making a linear relationship (no calculations); and
- relate the interpretation of the graph with the questions that were designed originally, or modify the original problem by taking into account the results of the graph analysis.

Materials:

- graph paper
- graphing calculator
- computer with graphing software

Procedure:

Present the following list of pairs of variables from Table 4: Suggested Pairs of Variables (General) to students and have them pick two pairs. You may choose to add more pairs to the list.

Table 4

Suggested Pairs of Variables (General)

Variable 1	Variable 2
Heart rate	Oxygen consumption
Heart rate	Age
Day of the week	Number of speeding tickets
Number of houses sold	Month of the year
Life expectancy	Each year after 1900
Distance between two major cities	Cost of airline ticket
Value of the Canadian dollar/US dollar	Each month after 1996
Height of Grade 9 students	Mass of Grade 9 students
High school drop-out rate	Each year since 1990
Month of the year	Level of water consumption
Colour of car	Number of accidents
Self-employed workers	Each year since 1990
Number of single family houses/condominiums sold	Price of single family house/condominium
Distance from school	Time required to travel to school
Percentage of voters for a party in an election	Number of seats in the legislature
Percentage federal taxes	Taxable income
World record for the 100 m dash	Age of the record holder
Level of blood glucose	Hour of the day

Table 5

Suggested Pairs of Variables (Project-Related)

Variable 1	Variable 2
Number of hours spent in a library	Grade level
Number of hours/week spent on a leisure activity	Distance from the house to the location where the activity takes place
Number of hours/week spent on a leisure activity	Number of hours spent on the phone with friends
Distance from the house to the location where the activity takes place	Time needed to travel from the house to the location where the activity takes place
Number of hours spent on the phone with friends	Day of the week
Number of hours/week spent on a leisure activity	Time needed to travel from the house to the location where the activity takes place
Number of hours/day spent on a leisure activity	Day of the week
Number of hours/week spent on a leisure activity	Age

Ask students to formulate one or two questions about the data set they are going to prepare.

Have them collect data from the appropriate information sources or to design and conduct an experiment that allows them to collect the necessary data. They should mention the source of their information or the details of their experiments.

Students then represent their data in the form of a table and that of a graph. Students may use Student Activity, Figure 7: Generic Graph for this purpose. Encourage students to use available technology for their graphs.

If applicable, ask students to draw the line of best fit using the available technology.

Ask students to comment on the relationship between the two variables and to present a rigorous written analysis. This analysis should include a description of the two variables, a description of the relationship in terms of linearity or non-linearity, the eventual domains of linearity, and the way the relationship could be made linear if it does not appear to be.

Ask students to prepare a short report on their findings. Remind students that the criteria described at the beginning of this activity are used to evaluate the activity.

Phase III: Application

Activity 1: Application of Concepts to Community Needs

Objective:

At this point, students have the necessary tools to conduct their survey and to begin an analysis of any correlation among the pairs of project variables.

At the end of this activity, the students present a description of the recreational, cultural, and physical needs of youth in the community from the survey they conducted among 13-16 year olds. This includes collecting data, representing and analysing the results, and making recommendations.

Materials:

- blank table and graph forms
- graphing calculator
- computer with graphing software

Procedure:

Ask students to create as many pairs of two variables as the ones presented in the previous activity and record these pairs using Table 7: Suggested Pairs of Variables (General).

Ask them to design as many questions as necessary to be able to produce a rigorous analysis of the recreational needs of community youth.

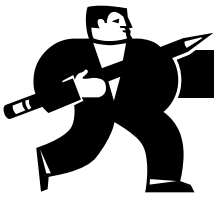
Students are expected to present their results in the form of tables and graphs, to analyse the results in terms of two variables, and to make recommendations to the class. Students may wish to design their own data tables and use Figure 7: Generic Graph to record their results.

The results should be presented by gender, age, area of residence in the community, distance from existing facilities, time required to travel from home to the existing facilities, and so on.

The results obtained may be used in other activities as examples of determining relationships between two variables.

Insist on clarity and conciseness in the questions they use to design the survey:

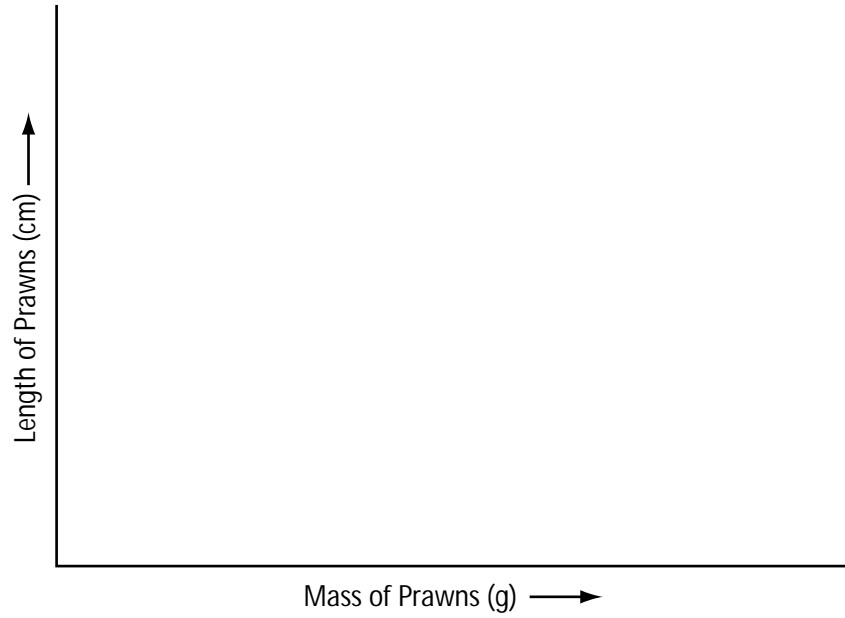
- one single topic at a time
- precision of the questions
- simplicity
- two variables involved at a time

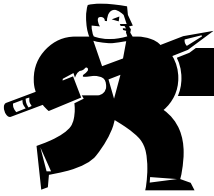


Student Activity: Prawns

Student Name: _____ Date: _____

Figure 6: Prawns



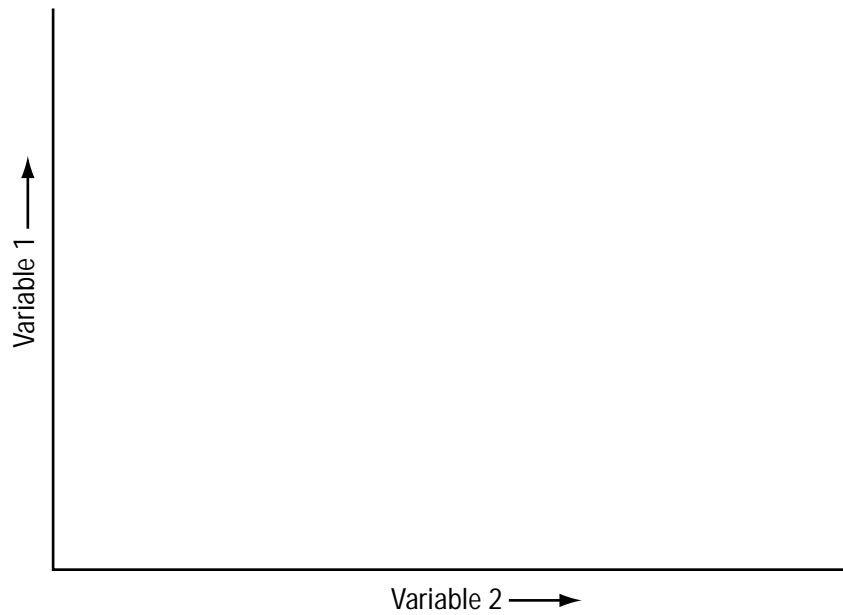


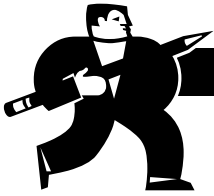
Student Activity: Generic Graph

Student Name: _____ Date: _____

You should be provided with several copies of Figure 7 below.

Figure 7: Generic Graph





Student Activity: Example of a Survey

Student Name: _____ Date: _____

1. Preparing the survey

General information

- School:
- Grade:
- Contact Name:
- Number of students:
- Other:

Main topic

- What is the specific information your group has been asked to obtain?

Supplementary information

- What additional information do you think is important to obtain and why?

2. Collecting Data

Determine the type of survey to be distributed for the collection of the data, for example, telephone interview, face-to-face interview, or questionnaire.

Population and Sample size

- Describe the population your group has been asked to survey:
 - age
 - gender
 - other characteristics
- Describe the number of students to be surveyed (sample size):
 - age
 - gender
 - other characteristics
- Describe the percentage of the population:
 - age
 - gender
 - other characteristics



Student Activity: Example of a Survey

Brainstorm the specific information related to your task that you would like to obtain during the interview, for example, age, swimming pool use, public library use.

Decide upon a format for each question. For example,

- Do you think that a 50m swimming pool is important for our community?

Not Very Important 1 2 3 4 5 Very Important

Organize and regroup your questions into sections and identify the purpose of each section. Organizing and regrouping your questions before you do the survey helps you compile the results later.

For example,

Section 1: General information

- What is your age?
- Gender: M F
- Where do you live?

Section 2: (currently, I)

- Are you enrolled in ... ?
- How many hours do you spend on ?

Section 3: (if ..., I would)

- use ... 3, 4, ... times a week,

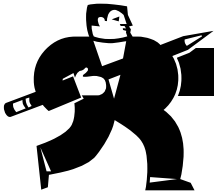
Section 4: (if I have to choose between ... and ..., I would prefer ...)

Tips

Before writing the final questionnaire check with your teacher to see if there is a school or school district policy regarding the kinds of questions you can ask or regarding student participation. Once you have this information, test out (pilot) your questionnaire with some friends. Use their feedback and the results to adjust and fine tune the questions. Submit the questionnaire to your teacher for final comments and suggestions before you actually conduct your research.

Make the required number of copies of the questionnaire.

Use a checklist to make sure that you are ready to conduct the survey.



Student Activity: Example of a Survey

If you decide to conduct interviews, do not influence the answers. For example, allow the same amount of time for each interview to take place, ask each person the questions in the same order using the same tone of voice.

3. Presenting and analysing results

Select the most appropriate format for presenting your survey results. Explain your selection.

Compile the results by section and construct tables (see samples) before drawing the graphs. Construct a table for each section of questions and write a title for the table. See the example on the following pages.

Make all the calculations including averages and draw conclusions.

What are some conclusions you can make from your graphs?

What are the recommendations of your group as a result of your survey?

Sample

Suppose your group was given the task of determining the need for a swimming pool. You may consider presenting your results in the form of a table like the one below.



Student Activity: Example of a Survey

Table 8

Swimming Pool Survey Results

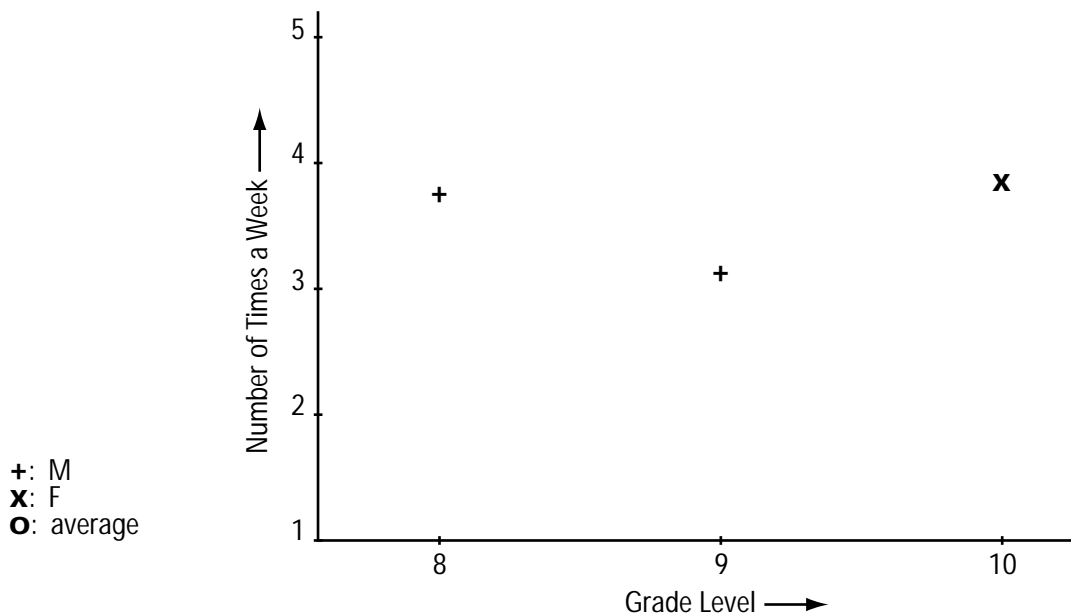
Grade	M	F	Rating Scale					Average Rating Males	Average Rating Females	Overall Average Rating	Remarks
			1	2	3	4	5				
8	6	5	0	1	2	2	1	3.5	3.8	3.75	
9	4	7	0	1	2	2	1	3.0	3.2	3.1	
10	6	7	0	1	2	2	1	3.7	4.0	3.85	
Total/Ave.	16	19	0	3	6	6	3			3.57	

Rating Scale Key:

- 1: not important at all
- 2: not very important
- 3: somewhat important
- 4: important
- 5: very important

Present your data on a graph and clearly label the axes.

Figure 8: Frequency of Student Use of Swimming Pool



Draw your conclusions and make recommendations.

Activity 2: The Plan

Objective:

Students are asked to reach a consensus regarding the choice of features for the facility and their relative location in order to meet the needs expressed in the survey.

Students also decide how to distribute the tasks amongst themselves (forming specialized groups for each of the activities).

Materials:

- survey results from each group

Procedure:

Guide students in their decision-making process. Ensure that their interpretation is consistent with the results of the survey.

Impose a time limit on the discussions. Students should reach a decision within the class period and a first draft of the proposal should be completed as an assignment for the next class.

Prior to the second period allowed for the planning, prepare a format where the different components are identified and the tasks are clearly defined, Ensure that students know who is doing what, when, and how. Also, the format should explain the purpose of the activities, the usefulness of the corresponding mathematical concepts, and how they are related to the project.

The students form groups. Each group's tasks are described specifically with respect to the project. Each group should complete each of the activities while keeping its own group's specific task in mind.