

Course
MTH-4152-1
Data Collection in a General Context

Mathematics



INTRODUCTION

The goal of the *Data Collection in a General Context* course is to enable adult learners to deal with situations that involve collecting or processing data pertaining to a one or a two-variable distribution in a general context.

In this course, adult learners continue to learn about descriptive statistics and begin to make intuitive inferences. In order to make informed decisions in realistic situations, they use their number and operation sense, proportional reasoning and the concept of statistical data to interpret and evaluate conjectures. Their decisions can also be based on an analysis of different sources of bias or the effect of changing certain elements, or on a calculation of other relevant measures. In situational problems, adult learners make decisions based on statistical data. They organize data and study one- or two-variable distributions in which they must determine statistical measures (correlation coefficient, measures of central tendency, dispersion or position). For example, they may be asked to describe a population and draw conclusions about it. Lastly, they may be required to describe a situation based on a graph or table of values. In some cases, they may have to write a series of questions before collecting data or producing a statistical report. In other cases, they can identify and interpret different measures that they themselves or others have taken.

By the end of this course, adult learners will be able to collect data. They will also compare other, similar sets of data when solving a problem that they themselves have defined. They will present the results of their analysis in accordance with the rules and conventions of mathematics. They will use problem-solving strategies to make the best decisions and determine the most accurate solution. In addition, they will be able to use mathematical reasoning to interpret statistical information resulting from the collection of data.

SUBJECT-SPECIFIC COMPETENCIES

In order to solve the situational problems in this course, adult learners will use the following three subject-specific competencies:

- *Uses strategies to solve situational problems*
- *Uses mathematical reasoning*
- *Communicates by using mathematical language*

The use of effective strategies involves employing rigorous mathematical reasoning and communicating clearly by observing the codes and conventions of mathematical language. Adult learners solve situational problems by using all three subject-specific competencies and other resources.

The following section explains how to use the three subject-specific competencies to solve a situational problem.

PROCESS AND STRATEGIES

To solve a situational problem, adult learners need effective strategies that they can adapt to the situations at hand.

Adult learners solve situational problems using a four-phase process:

- **representation**
- **planning**
- **activation**
- **reflection**

The following table gives an overview of the phases in the problem-solving process, as well as a few examples of strategies adult learners can use in dealing with various situations. These phases are not necessarily carried out in the order indicated above. Adult learners may have to go back and forth among the four phases in order to solve a situational problem.

PROCESS AND STRATEGIES	
REPRESENTATION	
<ul style="list-style-type: none"> - Adult learners examine the situational problem to identify the context, the problem and the task to be performed. - They use observational and representational strategies that are essential to inductive reasoning. - In attempting to understand the context and the problem, they use deductive reasoning, particularly in situations that involve implicit data. 	
Examples of strategies	<ul style="list-style-type: none"> • Writing literal expressions to represent the elements of the situation that seem relevant, thus making it easier to find a relationship between variables when looking for a correlation • Organizing data from a sample in order to describe a population and make it easier to process the information • Listing their statistical strategies and knowledge pertaining to the situation • Describing the characteristics of the situation • Gathering relevant information
PLANNING	
<ul style="list-style-type: none"> - In planning their solution, adult learners look for ways of approaching the problem and choose those that seem the most efficient. - They develop a plan, taking into account the elements of mathematical language (symbols, terms and notation used, and the different registers of representation). - Through reasoning, they establish organized and functional relationships among different aspects of their knowledge, thus expanding their networks of cognitive resources. 	
Examples of strategies	<ul style="list-style-type: none"> • Systematically determining the correlation model best suited to the situation, bearing in mind that the dispersion of the data must be taken into account in order to make the right choice • Determining the most appropriate measures of central tendency and dispersion in order to establish connections between data values
ACTIVATION	
<ul style="list-style-type: none"> - When dealing with a situational problem, adult learners can make connections between the graphical representation, the correlation coefficient and the interdependence of the variables involved. - By drawing on their knowledge of statistics, they are able to deduce certain relationships 	
Examples of strategies	<ul style="list-style-type: none"> • Using a table to connect the elements associated with the correlation: ordering the statistical data, finding the median, mean, mean deviation and so on • Drawing the regression line based on the means or medians • Using technology (e.g. spreadsheet program, graphing calculator) to analyze the role of the different parameters of the rule of the correlation line
REFLECTION	
<ul style="list-style-type: none"> - Adult learners use a reflective approach throughout the situation and always review the phases in the problem-solving process and the choices made, with a view to validating the solution. - Reasoning can be used to reject extrapolations that would yield nonsensical results. - When decoding mathematical elements, adult learners make sure they can distinguish between the everyday meaning of the terms used and their meaning in statistics. 	
Examples of strategies	<ul style="list-style-type: none"> • Checking their solution by substituting the values of the variables in the algebraic expression of the regression line in order to validate a graphical interpolation or extrapolation, etc. • Using a spreadsheet program to validate their work.

CROSS-CURRICULAR COMPETENCIES

Cross-curricular competencies are not developed in a vacuum; they are rooted in situational problems. To varying degrees, the cross-curricular competencies contribute to the development of the subject-specific competencies, and vice versa.

Several cross-curricular competencies can be useful in dealing with the *Processing data* family of learning situations. Two of these are considered particularly relevant to this course: *Exercises critical judgment* and *Uses information and communications technologies*.

Intellectual Competency

Situations that involve statistics require adult learners to use the competency *Exercises critical judgment* before deciding on the relevance and validity of the information based on given criteria that reflect the goal of a study. For example, checking a correlation between two data values or accurately calculating measures of position and dispersion could help adult learners develop this competency by encouraging them to reject prejudices and preconceived ideas. The study of statistics and probability could help them understand the role that reason and preconceived notions play in the formation of an opinion.

Methodological Competency

The competency *Uses information and communications technologies* is a definite asset for anyone who intends to work with statistical distributions. Among other things, a spreadsheet program is used to calculate standard deviation, draw a graph for a one-variable distribution, calculate a correlation coefficient and draw a scatter plot for a two-variable distribution.

SUBJECT-SPECIFIC CONTENT

In this course, adult learners use and build on some of their previously acquired mathematical knowledge. In order to deal effectively with situational problems, they will add to what they have learned by mastering the mathematical knowledge specific to this course.

Prescribed Knowledge

In order to deal effectively with the learning situations in this course, adult learners develop the following three integrative processes:

- **collecting data**
- **comparing collections of data**
- **interpreting data resulting from an experiment**

These processes, which are applied in the learning situations in this course, foster the integration of mathematical knowledge and the subject-specific competencies. The learning situations must involve at least one of these integrative processes. However, there must be a sufficient variety of learning situations to cover all three processes. The learning situations may be purely mathematical or based on everyday events.

Mathematical Knowledge	Restrictions and Clarifications
One-variable distribution	
<ul style="list-style-type: none"> • Determining and interpreting measures of position and dispersion 	<p>The measures of position and dispersion studied are:</p> <ul style="list-style-type: none"> • percentile • mean deviation <p><i>In the analysis and interpretation of a distribution, the adult learners' understanding of mean deviation should be considered more important than the calculations involved.</i></p>
<ul style="list-style-type: none"> • Representing statistical data related to a population or a sample 	<p>The register of representation studied is the stem-and-leaf plot.</p>
Two-variable distribution	
<ul style="list-style-type: none"> • Constructing and interpreting two-variable distributions 	<p>In the study of linear correlation, analysis and communication should be considered more important than calculations.</p>
<ul style="list-style-type: none"> • Drawing a scatter plot 	

Mathematical Knowledge	Restrictions and Clarifications
Two-variable distribution (cont.)	
<ul style="list-style-type: none"> Representing the regression line by means of a rule or graph 	<p>In this course, adult learners need only approximate the equation of the regression line. They could determine the equation of the line using two points in the scatter plot, one of which could be the mean of the x- and y-intercepts.</p> <p>The regression line can be determined using the median-median line method or the Mayer line method. However, these methods are optional.</p>
<ul style="list-style-type: none"> Interpolating or extrapolating using the regression line 	
<ul style="list-style-type: none"> Approximating and interpreting the correlation coefficient 	
<ul style="list-style-type: none"> Interpreting a correlation qualitatively and quantitatively 	<p>The characteristics of the correlation are: positive, negative, zero, perfect, strong, moderate or weak.</p> <p>Interpretation of the correlation is limited to cases involving linear correlations, which can be estimated using a graphical method (box method or ellipse). The exact value of the correlation coefficient is determined using technology.</p>

Cultural References

Statistics play a major role in our society. Newspapers are full of examples of statistical data: the annual number of deaths related to smoking over the last 20 years, the success rate of an employment program by age or region, or the number of goals and assists scored by National Hockey League players. Data in statistical reports influence the decisions of corporations, municipalities, insurance companies and a variety of other organizations in different fields. In addition, the advent of computers has made it considerably easier to process these data.

Adult learners who like hockey could, for example, use data compiled in sports magazines to check whether there is a correlation between the number of goals scored by a forward and the amount of ice time he gets.

FAMILY OF LEARNING SITUATIONS

The situations in the family *Processing data* involve problems that can be solved in part by collecting or processing data in a general context. The *Data Collection in a General Context* course provides adult learners with an opportunity to learn how to collect and compare data.

In the situational problems in this course, adult learners establish organized and functional relationships among different aspects of their knowledge, thus expanding their networks of cognitive resources, deduce certain relationships in a situation by drawing on their knowledge of correlation, and exclude data from a correlation analysis because they are too far from the scatter plot.

BROAD AREAS OF LEARNING

The broad areas of learning deal with major contemporary issues. Ideally, the situations to be studied should be selected in keeping with the educational aims of the broad areas of learning, which provide the situational problems with contexts that make the learning process meaningful. Two broad areas of learning are considered particularly relevant to this course: Environmental Awareness and Consumer Rights and Responsibilities, and Career Planning and Entrepreneurship.

Environmental Awareness and Consumer Rights and Responsibilities

The concepts of linear correlation studied in this course could help adult learners make better financial decisions when buying insurance. Adults could establish the correlation between each of the factors that affect the cost of the insurance and the payments to be made in order to be covered. A comparison of various insurance options could then be conducted. Adult learners will be better equipped to make informed consumer decisions, which ties in with one of the focuses of development of this broad area of learning.

Career Planning and Entrepreneurship

Various services such as a cafeteria or a student radio station can be offered in an adult education centre. Before providing these services, it is necessary to make sure that they meet learners' needs. In addition, these services must be adjusted as the student population changes. Studying statistical data—particularly the relationships between different factors and extrapolation based on historical and current data—will help adult learners make informed decisions regarding such a project. Carrying out a project of this scope enables them to fulfill their potential and carve out a place for themselves in society, which ties in with the educational aim of this broad area of learning.

EXAMPLE OF A LEARNING SITUATION

All learning situations and situational problems, regardless of the broad area of learning to which they are related, require the active participation of the adult learner. They provide an opportunity to develop the targeted subject-specific and cross-curricular competencies, to acquire mathematical concepts and to mobilize a variety of useful resources.

The table below presents the elements needed to develop a learning situation or situational problem. It specifies these elements for the situational problem described on the following page.

ELEMENTS NEEDED TO DEVELOP A LEARNING SITUATION OR A SITUATIONAL PROBLEM	
Targeted broad area of learning	<ul style="list-style-type: none"> • Environmental Awareness and Consumer Rights and Responsibilities
Prescribed subject-specific competencies	<ul style="list-style-type: none"> • Uses strategies to solve situational problems • Uses mathematical reasoning • Communicates by using mathematical language
Prescribed family of learning situations	<ul style="list-style-type: none"> • Processing data
Targeted cross-curricular competency	<ul style="list-style-type: none"> • Exercises critical judgment
Prescribed essential knowledge	<ul style="list-style-type: none"> • See list

This section provides an example of a situational problem along with possible tasks involved in its mathematical processing. The context can be used as a common thread throughout the learning situation. The learning activities are not spelled out; rather, the focus is on a relevant example of mathematical processing using the four phases in the problem-solving process: representation, planning, activation and reflection. Although not explicitly stated, the elements of the situational problem identified in the previous table, i.e. the broad area of learning, subject-specific competencies, family of learning situations, cross-curricular competencies and essential knowledge, can be discerned, and must form a coherent and meaningful whole.

Teachers may choose to use any of these elements as objects of learning. For instance, learning can focus on actions associated with the phases in the problem-solving process, actions related to the subject-specific or cross-curricular competencies, or actions related to the prescribed knowledge. Teachers can also use the example provided to construct other complex tasks or learning activities related to the mathematical knowledge adult learners must acquire.

Situational problem	Examples of possible tasks involved in the mathematical processing of a situational problem belonging to the <i>Processing data</i> family of learning situations
<p>An adult learner wants to buy car insurance.</p> <p>He realizes that there is discrimination involved in determining premiums. For example, the driver's age and gender affects the amount of the premium.</p> <p>Adult learners are asked to analyze and interpret the different factors that affect the cost of insurance premiums.</p>	<p>Integrative process: <i>Comparing collections of data</i></p> <p>In carrying out the four phases in the problem-solving process, adult learners could:</p> <p>Representation</p> <ul style="list-style-type: none"> • Consult statistical reports on the SAAQ Web site • Obtain information on car insurance rates from one or more insurance companies <p>Planning</p> <ul style="list-style-type: none"> • Determine the variables that can be correlated, for example: <ul style="list-style-type: none"> – the amount of the premiums and the driver's age – the amount of the premiums and the number of claims filed – age and number of accidents – the number of years of driving experience and the cost of the premiums

Situational problem	Examples of possible tasks involved in the mathematical processing of a situational problem belonging to the <i>Processing data</i> family of learning situations
	<p>Activation</p> <ul style="list-style-type: none"> • Make conjectures based on the type of correlation involved. For example, adult learners could assume that premiums that are justified by the link between the driver's age and the number of accidents in this age category could also be related to geographic location. This conjecture could also be confirmed through another statistical analysis. <p>Reflection</p> <ul style="list-style-type: none"> • Draw conclusions from an analysis of the results by distinguishing relevant from irrelevant information

END-OF-COURSE OUTCOMES

To solve situational problems in the family of learning situations *Processing data*, adult learners collect, compare and interpret data resulting from an experiment. To do this, they use the three subject-specific competencies, *Uses strategies to solve situational problems*, *Uses mathematical reasoning* and *Communicates by using mathematical language*.

To collect data, adult learners use problem-solving strategies to identify the issue and define the tasks to be carried out. They determine the important elements and the obstacles to be overcome, with a view to differentiating between one- and two-variable statistical distributions. In addition, in working out their solution, they establish and carry out a plan involving the previously validated steps: data collection and processing (interpretation and analysis). The last two steps require that they use mathematical reasoning to explore the issue in question and identify patterns. They make conjectures based on a correlation line in order to make decisions in the medium or long term. For example, they draw conclusions when they derive laws or rules associated with percentile and mean deviation. Lastly, to produce mathematical messages, they use an appropriate register of representation given the constraints of the situational problem: Mayer line, median-median line, table or stem-and-leaf diagram in the case of a one-variable statistical distribution.

To compare collections of data, adult learners interpret a mathematical message, making connections between the elements of the message, determining its overall meaning, or associating pictures, objects or knowledge with mathematical terms and symbols. In addition, they use mathematical reasoning to compare trends, developing and using networks of mathematical cognitive resources such as percentile, mean deviation and correlation coefficient.

To interpret data resulting from an experiment—one- or two-variable statistical distributions—adult learners decode the elements of mathematical language, distinguishing between the mathematical and everyday meanings of terms. In addition, they interpret mathematical messages, switching from one register of representation to another (e.g. from a stem-and-leaf diagram to a one-variable data table) and making sure they understand what is involved. They use mathematical reasoning to develop networks of mathematical cognitive resources, such as the Mayer line or median-median line, and to determine the correlation coefficient using the box method or ellipse. They make generalizations, derive laws and rules, and deduce propositions in order to make informed decisions.

Throughout the problem-solving process, adult learners apply their mathematical knowledge (one- or two-variable statistical distributions). Their use of symbols, terms and notation related to this knowledge is accurate, and they always refer to different sources to validate the laws, theorems, corollaries or lemmas they deduce or induce so that they can improve their mathematical literacy. In addition, they do not hesitate to ask for help when they encounter difficulties.

EVALUATION CRITERIA FOR THE COMPETENCIES TARGETED BY THE COURSE

Uses strategies to solve situational problems

- *Indication (oral or written) that the situational problem has been understood*
- *Application of strategies and appropriate mathematical knowledge*
- *Development of an appropriate solution**
- *Appropriate validation of the steps** in the solution*

* The solution includes a procedure, strategies and a final answer.

** The mathematical model, operations, properties or relations involved.

Uses mathematical reasoning

- *Formulation of a conjecture suited to the situation*
- *Correct use of appropriate mathematical concepts and processes*
- *Proper implementation of mathematical reasoning suited to the situation*
- *Proper organization of the steps in an appropriate procedure*
- *Correct justification of the steps in an appropriate procedure*

Communicates by using mathematical language

- *Correct interpretation of a mathematical message*
- *Production of a message in keeping with the terminology, notation and conventions of mathematics, and suited to the context*