APPENDIX A: RECOMMENDATIONS FOR INTEGRATING NUMERACY
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RECOMMENDATIONS FOR INTEGRATING NUMERACY

Numeracy is a part of everyday life in Alberta. Setting an alarm clock, changing channels on the television, checking a weather forecast, reading a bus schedule, paying for merchandise and checking one’s change are all everyday numeracy applications. Many learners with interrupted formal education (LIFE) struggle with these tasks, because they have not had the opportunity to develop basic numeracy skills. Numeracy is the knowledge, skills and language necessary to communicate about and use mathematics in everyday situations. It includes:

- understanding whole and decimal numbers
- adding, subtracting, multiplying and dividing
- recognizing patterns
- deciphering data in tables, graphs and charts
- understanding measurement and geometry
- identifying the mathematics required to calculate answers and solve problems

Basic numeracy skills contribute to a learner’s ability to cope independently with everyday life in Canada. “These skills are as important in everyday life as being able to read and write” (Centre for Canadian Language Benchmarks, 2000, p. iv).

Numeracy Learner Profiles

LIFE have a range of mathematical understanding and experience. The learner profiles here illustrate the range of numeracy skills you may find in your classroom or program.

Learner A
This learner shops and spends money, but relies on cashiers to take cash and change from her purse. She cannot count orally in English, and cannot add or subtract one or two digit numbers.

Learner B
This learner refers to being taught math ‘a long time ago’. He cannot articulate mathematical processes, but can mentally add and subtract very quickly, and he knows some times tables by rote. He used to assist his father in the family’s shop in his home country.

Learner C
This learner is a confident and competent mathematician. She completed nine years of schooling in her home country and loves finding solutions to problems, but she struggles to identify the key mathematical language required in English in order to calculate correctly.

For more detailed numeracy learner profiles, see Chapter 12 of Learning for LIFE: An ESL Literacy Handbook.
As illustrated in the profiles, some learners need to develop foundational numeracy skills, while others need to learn more advanced skills. Other learners have strong math skills, but need to learn the English necessary to be able to demonstrate their existing knowledge and skills. For learners who plan to transition into career training or adult basic education programs, numeracy skills and the English to describe mathematical processes and solve problems are particularly important.

In this section, you will find:

- Program Considerations for integrating numeracy skills
- Classroom Considerations for integrating numeracy skills
- an excerpt from a sample Bow Valley College numeracy curriculum
- helpful resources
PROGRAM CONSIDERATIONS

In this section, we highlight several considerations from a programming perspective. These are intended to guide you in the process of incorporating numeracy into your adult ESL literacy curriculum.

Align Approach with your Program Purpose and Goals

In your program, learners’ numeracy skills will vary and they do not always correlate with literacy levels. For example, a learner’s literacy levels may fall into the Phase II range, according to the Canadian Language Benchmarks 2000: ESL for Literacy Learners. The same learner may have low numeracy skills that fall into the Foundation Phase range. Given that learners have different mathematical experiences and understanding, multi-level classrooms are often the reality.

You will need to determine your approach to numeracy instruction based on learners’ needs (see Stage 1: Understand Needs) and the focus of your program (see Stage 2: Determine Focus).

In this section, we outline three common approaches to integrating numeracy instruction, and the benefits and challenges of each:

- offer separate, leveled classes specifically for numeracy instruction
- integrate numeracy into thematic instruction in the ESL literacy class
- offer designated multi-level numeracy time within the ESL literacy class

Offer Separate, Leveled Classes Specifically For Numeracy Instruction

In this approach, learners can be grouped according to numeracy understanding and knowledge gaps, and transition between classes as their numeracy skills develop. They can work through clear objectives and experience success as they move from one level to the next. Instructors can focus on particular skills and knowledge gaps and develop vocabulary. The benefit of this approach lies in the opportunity to provide highly focused numeracy instruction that is systematically organized based on the development of mathematical concepts and skills.

The main challenge of this approach is that, while learners’ numeracy levels are similar, their language and literacy levels may not be. This may make discussion or explanation of mathematical concepts more difficult than when learners have similar language proficiencies. As the focus is numeracy development, many instructors choose to address this challenge by encouraging learners to support one another in their first languages, where possible.
Other challenges of this approach involves delivering numeracy instruction in a fixed, regular timeslot so that learners can attend the class that is the most appropriate for them. As well, outcomes must be clearly articulated for each level, and transition criteria between classes must also be agreed upon. It is important to conduct numeracy assessments at the beginning and end of a period of study.

Integrate Numeracy into Thematic Instruction in the ESL Literacy Class

In this approach, the instructor looks for opportunities to introduce numeracy into thematic teaching within the ESL literacy classroom. For example, in a theme around transportation, numeracy content could include:

- reading tables and schedules
- reading analog and digital time (including the 24 hour clock)
- using money in daily transactions
- reading maps including navigation of grid systems and compass directions

The greatest benefits of this approach are the reinforcement of the themed material and vocabulary and the opportunities to make the numeracy as ‘real’ as possible. Learners who are experienced in using math and performing necessary calculations in their lives will still benefit from learning the language to explain their calculations and decisions in English. Learners with limited numeracy skills will benefit from both the numeracy and the language instruction.

Challenges of this approach can arise with differentiation of resources and activities, as some learners will be experiencing or learning the material for the first time and others will be learning the English vocabulary for knowledge and skills they already possess. It is crucial to continually adopt a ‘show me what you know’ approach (see Classroom Considerations in this section) to inform instructional planning.

Offer Designated Multi-Level Numeracy Time in the ESL Literacy Class

In this approach, a certain amount of time is regularly designated for numeracy in the schedule. Because learners are still grouped according to literacy level, numeracy instruction is multi-level.

The main benefit of this approach is that numeracy concepts and skills can be introduced sequentially and built upon. Other benefits include providing learners with a new opportunity to share their knowledge and skills with their peers. Learners are mentors and teachers in this approach – roles they may not otherwise feel confident taking on in their literacy classroom.

The main challenge of this approach is in differentiating materials and instruction in order to meet the needs of learners with a variety of skill levels. As well, the instructor will need to conduct ongoing assessment for learning (formative assessment) as each individual will arrive with different levels of knowledge and skill gaps.
Identify Learners’ Starting Points

Regardless of which approach you choose to take, it will be important to determine learners’ existing numeracy needs and levels of understanding. Individual learners will have different gaps in their numeracy concept and skill development.

One approach to identifying learners’ numeracy starting points is to conduct a successive numeracy assessment. In this approach, learners move through a series of increasingly complex numeracy tasks. In order to move on to the next set of tasks, learners need to successfully complete the previous ones. The assessment can be completed over a period of time, rather than all at once.

This chart illustrates a successive numeracy assessment process.

| Assessment 1 | Identify patterns | Identify numbers |
| Assessment 2 | Read and write numbers in words and digits | Add and subtract single-digit numbers |
| Assessment 3 | Add and subtract two- and three-digit numbers | Multiply and divide simple calculation |
| Assessment 4 | Solve word problems with the four operations | Calculate with money |
| Assessment 5 | Use fractions, ratios and percents |

Adapted from Bow Valley College (2009)

Access the Financial ESL Literacy Toolbox through the ESL Literacy Network (http://www.esl-literacy.com) for a placement assessment which correlates with Phases I – III in the Canadian Language Benchmarks 2000: ESL for Literacy Learners. This three-tiered assessment is designed to reveal knowledge gaps and inform planning and instruction in the areas of financial literacy and numeracy.
Determine Numeracy Outcomes

Integrating numeracy outcomes provides a focus for instruction and increases accountability within a program (see Stage 3: Set Learning Outcomes). If you plan to integrate numeracy into your curriculum, you will need to determine the number of outcomes that are manageable for your program. Base this decision on learners’ needs, the approach you choose, and your program parameters such as the number of contact hours, levels and instructors.

In order to select or develop your numeracy outcomes, it is helpful to draw upon existing resources. In Alberta, there are two main resources that describe the progression of numeracy skills.

- **Canadian Language Benchmarks 2000: ESL for Literacy Learners** (Centre for Canadian Language Benchmarks, 2000)

- **Mathematics Kindergarten to Grade 9 Program of Studies** (Alberta Education, 2007)

This section provides a summary of the two resources and outlines the benefits and challenges of each.

**Canadian Language Benchmarks 2000: ESL for Literacy Learners**

The **Canadian Language Benchmarks 2000: ESL for Literacy Learners** document provides numeracy learning outcomes in Phases I, II and III. Within each Phase, you will find outcomes, sample tasks and applications and language and literacy competencies for developing numeracy skills. In each Phase, information about the learning conditions is also provided.

Numeracy learning outcomes are grouped into the following categories:

- number concepts
- patterns & groups
- operations
- time & temperature
- measurement
- money

The benefit of using this resource is that it is designed for adult ESL literacy learners. It links language instruction to numeracy instruction and provides examples for tying numeracy to content and real-life applications. However, in some cases (e.g. in educational or employment preparation ESL literacy programs), the numeracy outcomes may not extend to a high enough level. Depending on your program’s purpose and goals (see Stage 2: Determine Focus), you may need to further differentiate and extend the numeracy outcomes.
Mathematics Kindergarten to Grade 9 Program of Studies

This resource is designed for use in kindergarten through grade nine classes in Alberta.

--- Goals of the K-9 Program of Studies ---

The main goals of the mathematics education in the K-9 Program of Studies are to prepare students to:

- use mathematics confidently to solve problems
- communicate and reason mathematically
- appreciate and value mathematics
- make connections between mathematics and its applications
- commit themselves to lifelong learning
- become mathematically literate adults, using mathematics to contribute to society

Alberta Education (2007, p. 2)

This program of studies is divided into four strands, with some sub-strands. Each strand is addressed from kindergarten through grade 9, and is outlined below (Alberta Education, 2007, p. 8-9).

**Strand: Number**
- Develop number sense.

**Strand: Patterns and Relations**
- Patterns: Use patterns to describe the world and to solve problems.
- Variables and Equations: Represent algebraic expressions in multiple ways.

**Strand: Shape and Space**
- Measurement: Use direct and indirect measurement to solve problems.
- 3-D Objects and 2-D Shapes: Describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them.
- Transformations: Describe and analyze position and motion of objects and shapes.

**Strand: Statistics and Probability**
- Data Analysis: Collect, display and analyze data to solve problems.
- Chance and Uncertainty: Use experimental or theoretical probabilities to represent and solve problems involving uncertainty.
Consider selecting the most appropriate strands and adapting the outcomes, if your program’s purpose is to transition learners into a context that requires advanced numeracy skills or language related to numeracy. Some contexts in which this may be appropriate are educational preparation and employment preparation ESL literacy programs.

See Stage 2: Determine Focus for more information on educational preparation and employment preparation ESL literacy program contexts.

One considerable benefit of adapting the Mathematics Kindergarten to Grade 9 Program of Studies for an adult ESL literacy program is that the outcomes extend mathematical knowledge beyond what is provided in the Canadian Language Benchmarks 2000: ESL for Literacy Learners. In addition, there are areas of mathematical skill and understanding that are not addressed in the ESL literacy benchmarks. In programs that aim to develop learners’ numeracy and related language skills to a more sophisticated degree, it may be most appropriate to draw on this resource.

The main challenge in using the Mathematics Kindergarten to Grade 9 Program of Studies is that it does not address language and literacy development concurrently with numeracy development. If you intend to base your numeracy curriculum on the outcomes provided in this resource, it will be necessary to develop learning outcomes for the language and literacy skills needed in order to achieve the numeracy outcomes.

An excerpt from a numeracy curriculum based on the Mathematics Kindergarten to Grade 9 Program of Studies is provided at the end of this Appendix.
Support Instructors

Teaching numeracy may be unfamiliar to instructors in ESL literacy programs; they will need support, time and resources to develop their expertise and confidence in ESL numeracy instruction.

Being a math teacher is by no means a prerequisite for teaching numeracy to LIFE. However, it is key that instructors have expertise in ESL literacy instruction, and that they are given support to learn how to teach numeracy. Instructors should bring the best practices of literacy instruction to their numeracy teaching.

To provide numeracy instruction, ESL literacy instructors will need to:

- introduce mathematical concepts
- introduce and recycle mathematical vocabulary
- create activities that scaffold learning
- create ‘real-life’ scenarios for use in the classroom provide opportunities for learners to apply numeracy understanding and skills in the community
- devise activities to reinforce concepts and build confidence
- create opportunities for learner self-assessment and reflection

If you plan to introduce a numeracy component in your adult ESL literacy program, provide instructors with opportunities for professional development. Consider providing numeracy-related resources, workshops with numeracy experts and time for instructors to collaborate. Peer observations may also be helpful for those new to numeracy instruction.
CLASSROOM CONSIDERATIONS

This section highlights several considerations, from an instructional perspective. These are intended to guide you in the process of integrating and providing numeracy instruction to Learners with Interrupted Formal Education.

**Adopt a “Show Me What You Know” Approach**

Learners’ numeracy skills do not always correlate with their English language and literacy skills. Understanding learners’ numeracy knowledge and skills will help you provide instruction that is focused and intentional.

In adopting a “show me what you know” approach, you avoid making assumptions about individual learners’ numeracy skills. Create opportunities for your learners to demonstrate their numeracy skills and understanding in a variety of ways. Record learners’ ideas and knowledge, on their behalf if necessary. Use realia or visuals wherever possible to support brainstorming.

**Maintain a Strong Focus on Vocabulary Development**

Vocabulary development is a crucial aspect of numeracy instruction. Learners will need to develop their numeracy vocabulary in order to:

- explain their reasoning and decisions
- understand what is being asked of them in numeracy tasks, such as problem-solving

Approach vocabulary development in the same way you would in literacy-focused lessons. Build individual and classroom vocabulary banks throughout a unit of study. Recycle vocabulary frequently to ensure that it becomes familiar and understood. Encourage learners to use the vocabulary of the numeracy unit in their speech and writing.

It will be important to teach the names and pronunciation of English numbers. In addition to these, you may find it helpful to teach terms such as the following:

- plus
- minus
- times
- answer
- divided by
- equals
- difference
- percent
- sum
- total
- more
- less
- together
- place value
- maximum
- separate

All vocabulary will need to be contextualized, with visual or tactile support provided when possible. Learners will need to understand the numeracy concepts underlying the vocabulary you build in class. For some learners, this will mean simply learning the English word for
something they already know in their first language. For other learners, the numeracy concepts themselves will be new, in addition to the vocabulary.

**Facilitate Regular Small-Group Problem Solving**

Providing opportunities for small-group problem solving is valuable in numeracy instruction, as it gives learners an opportunity for collaboration, debate and conversation as they apply their numeracy knowledge and skills. Learners who share a first language can also share their numeracy knowledge with each other. As an instructor, this can help you navigate some of the challenges in communicating concepts to learners who have a range of oral English skills.

The following suggestions are provided to guide you in planning for small-group problem solving.

- Have learners work in mixed-ability groups to solve mathematical word problems. Each learner brings unique information and experience to the group.
- Create word problems that contain the unit vocabulary in real-life scenarios.

Encourage learners to explain and defend their decisions, and question and challenge the rationale of others, as this creates opportunities to use new vocabulary and skills.

**Create a Numeracy-Rich Environment**

Just as it is important to provide a print-rich environment for literacy development, providing a numeracy-rich environment is important for teaching numeracy. Create an environment in which learners are surrounded by resources and opportunities to learn and apply numeracy skills.

In your instruction, use manipulatives and realia wherever possible, avoiding explaining words with more words. For example, when developing financial literacy skills, using real coins helps learners attach meaning to vocabulary such as quarter, dime, nickel, penny, etc. Providing tangible objects, such as popsicle sticks, buttons, etc. for basic addition and subtraction can help learners grasp and apply numeracy concepts more effectively.
Make every effort to ensure that the learning setting contains the equipment and resources necessary to assist numeracy learning. This list represents an ideal ‘shopping’ list for an ESL numeracy class. It may not be possible to have all of the items on this list, but aim to provide as many as you can.

**For general or everyday use**

- individual whiteboards
- calculators
- graph paper
- pencils and erasers
- highlighters
- vocabulary bank templates
- counting blocks
- 2D and 3D shapes
- clocks
- large place value chart
- large vocabulary posters
- abacus
- measuring equipment: for mass, volume, length, cooking
- real coins and some paper money
- computer and computer games

**For games and activities**

- playing cards
- dice
- card games
- number flashcards
- equation flashcards

**For brainstorming and problem-solving**

- chart paper
- flipchart paper
- individual whiteboards

**From the community and banks**

- advertising flyers
- direct mail and bills
- newspapers
- coupons
- cheques
- gift cards (empty)
- money orders
- deposit slips
- withdrawal slips
- ATM receipts
- debit receipts
- shopping receipts

For sample numeracy lesson plans and resources targeting the development of financial literacy skills across Phases I, II and III of the ESL Literacy Benchmarks, please access the *Financial ESL Literacy Toolbox* through the ESL Literacy Network (http://esl-literacy.com).
SAMPLE: EXCERPT FROM A NUMERACY CURRICULUM

This sample provides an excerpt from a numeracy curriculum developed for the Bridge Program at Bow Valley College, based on the Mathematics Kindergarten to Grade 9 Program of Studies (Alberta Education, 2007).

The Context

This curriculum has been developed to meet the needs of learners aged 18-24, in the Bridge and Youth in Transition programs at Bow Valley College. These programs support learners at risk of not completing high school education, thus at risk of missing out on opportunities for post-secondary studies or career training. In developing the curriculum, it was important to include provincial mathematics outcomes as many learners will transition into further educational and career programs in Alberta, where this knowledge will be required, re-encountered and further developed.

The primary aims of the numeracy component in these programs are to:

- develop English mathematical vocabulary
- address mathematical knowledge and skills gaps
- develop problem-solving skills

Instruction in these programs takes place four hours per week. There are five different levels of classes into which learners are grouped according to their numeracy skills and understanding.

The Curriculum

Each of the five levels targets outcomes adapted from the Mathematics Kindergarten to Grade 9 Program of Studies. As LIFE have a range of numeracy understanding that has also been shaped by real life experiences and applications, each of these classes is multi-level.

An intake assessment is used to gauge new learners’ levels of numeracy and place them in one of the five classes. At the beginning of every new semester, learners take another placement assessment based on the content of the upcoming semester. These assessments place learners in the most appropriate levels, as it is recognized that all learners have different knowledge and knowledge gaps, and that there is not necessarily a correlation between a learner’s literacy and numeracy levels.
As learners are on individual learning paths, rather than in cohorts, it is not feasible to address all aspects of the Mathematics Kindergarten to Grade 9 Program of Studies. In developing the curriculum, the decision was made to prioritize three strands, which are offered over three semesters.

- Number and Operations: Semester 1
- Patterns and Data: Semester 2
- Measurement and Geometry: Semester 3

Within each strand, vocabulary development, small group problem solving and mental mathematics are the key areas of focus. In semesters 2 and 3, number and operations outcomes are reinforced where appropriate throughout the other strands.

The sample provided here details the patterns and data outcomes to be addressed in each of the five leveled classes (or levels). At the beginning of the semester, all learners take a placement assessment based on the upcoming content in order to identify their knowledge and skills gaps.

This version of the curriculum map was piloted in the Bridge Program at Bow Valley College during the 2010/2011 academic year.

<table>
<thead>
<tr>
<th>Patterns and Data Outcomes: Level 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patterns</strong></td>
</tr>
<tr>
<td>Use patterns to describe the world and solve problems</td>
</tr>
<tr>
<td>• identify, reproduce, extend and create repeating patterns (two to four elements) using manipulatives, sounds and actions</td>
</tr>
<tr>
<td>• sort a set of objects using one attribute and explain the sorting rule</td>
</tr>
<tr>
<td>• translate repeating patterns from one representation to another</td>
</tr>
</tbody>
</table>

Represent algebraic expressions in multiple ways

- record equalities using the equals sign
- describe equality as a balance and inequality as an imbalance, concretely and pictorially (0 to 20)

<table>
<thead>
<tr>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect, display and analyze data to solve problems</td>
</tr>
<tr>
<td>• gather and record data about self and others to answer questions</td>
</tr>
</tbody>
</table>
### Patterns and Data Outcomes: Level 2

#### Patterns

*Use patterns to describe the world and solve problems*
- describe, extend, compare and create numerical (to 1000) and non-numerical repeating and increasing patterns using manipulatives, diagrams, sounds and actions
- describe, extend, compare and create numerical (to 1000) and non-numerical decreasing patterns using manipulatives, diagrams, sounds and actions
- sort objects or numbers using more than one attribute and explain the sorting rule

*Represent algebraic expressions in multiple ways*
- demonstrate and explain the meaning of equality and inequality concretely and pictorially
- record equalities and inequalities using the equal or not equal sign
- solve one-step addition and subtraction equations involving a symbol to represent an unknown number

#### Data

*Collect, display and analyze data to solve problems*
- construct and interpret concrete graphs and pictographs to solve problems
- collect first-hand data and organize it using tally marks, line plots, charts and lists to answer questions
- construct, label and interpret bar graphs to solve problems
Patterns and Data Outcomes: Level 3

<table>
<thead>
<tr>
<th>Patterns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Use patterns to describe the world and solve problems</td>
<td></td>
</tr>
<tr>
<td>• identify and describe patterns found in tables and charts</td>
<td></td>
</tr>
<tr>
<td>• translate among different representations of a pattern, such as a table, a chart or concrete materials</td>
<td></td>
</tr>
<tr>
<td>• represent, describe and extend patterns and relationships, using charts and tables, to solve problems</td>
<td></td>
</tr>
<tr>
<td>• identify and explain mathematical relationships, using charts and diagrams, to solve problems</td>
<td></td>
</tr>
<tr>
<td>• determine the pattern rule to make predictions about subsequent elements</td>
<td></td>
</tr>
<tr>
<td>Represent algebraic expressions in multiple ways</td>
<td></td>
</tr>
<tr>
<td>• express a given problem as an equation in which a symbol or letter value is used to represent an unknown number (limited to whole numbers)</td>
<td></td>
</tr>
<tr>
<td>• solve one-step equations involving a symbol to represent an unknown number</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect, display and analyze data to solve problems</td>
<td></td>
</tr>
<tr>
<td>• demonstrate an understanding of many to one correspondence</td>
<td></td>
</tr>
<tr>
<td>• construct and interpret pictographs and bar graphs involving many to one correspondence to draw conclusions</td>
<td></td>
</tr>
<tr>
<td>• differentiate between first-hand and second-hand data</td>
<td></td>
</tr>
<tr>
<td>• construct and interpret double bar graphs to draw conclusions</td>
<td></td>
</tr>
</tbody>
</table>
## Patterns and Data Outcomes: Level 4

### Patterns

*Use patterns to describe the world and solve problems*
- represent and describe patterns and relationships, using graphs and tables

*Represent algebraic expressions in multiple ways*
- represent generalizations arising from number relationships, using equations with letter variables
- express a given problem as an equation in which a letter variable is used to represent an unknown number

### Data

*Collect, display and analyze data to solve problems*
- create, label and interpret line graphs to draw conclusions
- select, justify and use appropriate methods of collecting data, including questionnaires, experiments, databases and electronic media
- graph collected data and analyze the graph to solve problems
- demonstrate and understanding of central tendency (mean, median and mode) and determine the most appropriate measure to report findings
- construct, label and interpret circle (pie) graphs to solve problems
| Patterns | Use patterns to describe the world and solve problems  
• interpolate and extrapolate graphed data to solve problems |
|----------|----------------------------------------------------------|
| Data     | Collect, display and analyze data to solve problems  
• critique ways in which data is presented in circle graphs, line graphs, bar graphs and pictographs  
• describe the effects of bias, use of language, ethics, cost, time and timing, privacy, cultural sensitivity  
• select and defend the choice of using either a population or a sample of a population to answer a question  
• develop and implement a project plan for the collection, display and analysis of data |
HELPFUL RESOURCES


WORKS CITED

For a complete list of the works cited in this document and in Learning for LIFE: An ESL Literacy Curriculum Framework Please refer to www.esl-literacy.com/workscited2