Mathematics Essentials 12

Guide

NOVA SCOTIA
NOUVELLE-ÉCOSSE

2007

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Mathematics Essentials 12

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NOVA SCOTIA

Education
English Program Services

Mathmatics Essentials 12

CURRICULUM

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Introduction

Background

The Department of Education has made a commitment to provide a broad-based, quality education in the public school system and to expand the range of programming to better meet the needs of all students. The department has been working in collaboration with school boards and other partners in education, business, industry, the community, and government to develop a variety of new courses.

Math for the Workplace 12 is one of a group of innovative course options that share certain characteristics.

New course options draw from and contribute to students' knowledge and skills in more than one discipline. Students synthesize and apply knowledge and skills acquired in other courses, including courses in English language arts, social studies, sciences, visual and performing arts, mathematics, and technology.

New course options provide increased opportunities for senior high school students to earn credits they require to attain a high school graduation diploma, to diversify their program, and to prepare for varied post-secondary destinations. Course options are designed to appeal to all high school students; to assist students in making connections among school, the community, and the workplace; and to enable students to explore a range of career options. These courses offer students increased opportunities for hands-on experiences and for using the skills attained within a variety of subject areas to expand and develop their learning and skills.

Rationale

Over the last several years, instructors at post-secondary institutions have identified some areas that need improvement in terms of the mathematical knowledge base of students entering various trades.

Math for the Workplace 12 will aim to improve the students' mathematical knowledge base, and most aspects of the course will be directly related to numerous trades, including, but not limited to carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

Math for the Workplace 12 will help students to understand the relationship between their high school studies and a range of post-secondary destinations. The course focusses on examining career options, making choices, exploring the workplace, and developing employability skills, in addition to increasing the student's mathematical knowledge base.

One of the challenges of the senior high public school program is to offer students experiences that will help them respond to opportunities to participate in and contribute to the economy. Students need to build their awareness of such opportunities, to become increasingly flexible, and to develop an entrepreneurial spirit and initiative.

The Nature of Math for the Workplace 12

Math for the Workplace 12 is characterized by experiential learning.

Learning is an active process. Math for the Workplace 12 engages students in a range of purposeful and challenging experiences that actively involve them and are personally meaningful. Such experiences engage students in hands-on activity, investigating and taking risks, and making new discoveries and connections.

Students need opportunities to learn through experience and problem solving and to engage actively in independent learning where they can follow their own interests and pursue their own ideas. Math for the Workplace 12 invites learners to try their hands at real challenges, creating a powerful tool for innovation through project work for Modules I and II.

Math for the Workplace 12 supports student ownership of learning.

Students need to see their learning as relevant to their realities, their needs, interests, experiences, and values. They recognize learning as worthwhile when they see some value and application in what they are required to know and be able to do. They develop as lifelong learners when they see how learning contributes to their lives, giving them confidence in their ability to learn effectively.

Learners need a voice, determining what they will learn, how they might learn more effectively, and to what extent they can shape their learning experiences. Math for the Workplace 12 helps students to develop as independent lifelong learners by giving them opportunities to take responsibility for and make decisions about their own learning, to set learning goals, and to design, select, and direct their learning experiences.

Math for the Workplace 12 provides students with a central role in negotiating individual assessment and evaluation processes.

In addition to opportunities for self-assessment, students need regular feedback on their learning and performance from teachers, their peers, and others in the learning community. Students need a clear understanding of the focus of assessment, what learning they are to demonstrate, and what particular elements or qualities of learning are considered important. For example, if risk taking in learning is valued, then it is important to reward risk taking as part of determining marks or grades.

Learners need opportunities to explain and contribute to the development of evaluation criteria. They also need many and varied opportunities to demonstrate what they know and are able to do. Effective assessment practices, like effective student-centred instructional practices, incorporate varying learning styles and respond to students' particular learning needs.

Course Designation

While this graduation-level course is offered as a grade 12 mathematics course, it is not part of the two compulsory mathematics credits required for high school graduation. For graduation purposes, a student requires a mathematics credit at the grade 10 level and a mathematics credit at the grade 11 level.

Math for the Workplace 12 can be used as a technology credit (from the section stating "2 other electives from math, science, or technology") or as a grade 12 course to meet part of the required five grade 12 credits needed for graduation.

Math for the Workplace 12 is a graduation-level credit; however, occasionally a student who has taken grade 10 academic mathematics and grade 11 academic mathematics will choose to take the course if they have a trade career as part of their post-secondary goals. This type of student will need to understand that they will be expected to produce mathematical work at a higher level than others in the class, especially when completing Modules 2 and 4. Some independent work may be necessary for the student to improve their mathematical knowledge base.

Course Design and Components

Features of Math for the Workplace 12

Math for the Workplace 12 is characterized by the following features:

- an emphasis on integrating, applying, and reinforcing the knowledge, skills, and attitudes developed in other mathematics courses and extending this knowledge through practical application problems
- a connection to the Essential Graduation Learnings
- a refining of career-planning skills to explore a wide range of pathways from school
- a strong connection to labour market opportunities with a focus on enhancing employability skills
- a relationship to the community and workplace with a focus on using real community and workplace problems and situations as practical contexts for the application of knowledge and skills and for further learning
- hands-on learning experiences, including experiences with a range of technologies
- development of personal and interpersonal skills required for personal and career success
- use of technology as an integral part of the course

Math for the Workplace 12 is designed to increase the mathematical power of students interested in entering various trades and to better prepare them for the mathematics they will encounter in their coursework in their post-secondary training. The course focusses on active, experiential learning and on developing the knowledge, skills, and attitudes required to identify opportunities and meet the challenges of the workplace environment.

Organization

Math for the Workplace 12 consists of four modules—some of which can be taking place concurrently. Typically, students will begin with Module 1, then move into Module 2, during which students must schedule and carry out interviews with trades people. If this causes any delays with completing Module 2, then students can get started on Module 3 and subsequently Module 4.

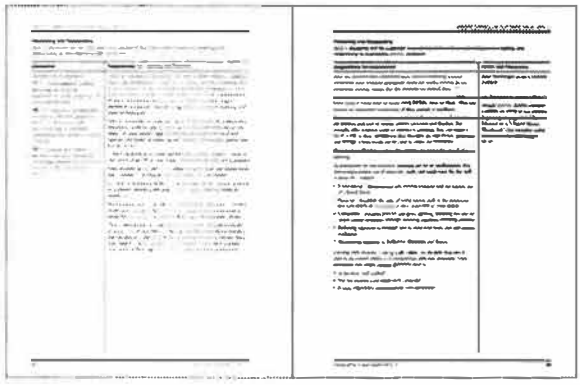
Prerequisite Options

Students who wish to enrol in Math for the Workplace 12 must have successfully completed one mathematics course at the grade 10 level and one mathematics course at the grade 11 or 12 level.

The Two-Page, Four-Column Spread

The curriculum for this course has been organized into four columns for several reasons:

- The organization illustrates how learning experiences flow from the outcomes.
- The relationship between outcomes and assessment strategies is immediately apparent.
- Related and interrelated outcomes can be grouped together.
- The range of strategies for teaching and learning associated with a specific outcome or outcomes can be scanned easily.
- The organization provides multiple ways of reading the document or locating specific information.



Column One: Outcomes

This column describes what students are expected to know, be able to do, and value by the end of this course. While the outcomes may be clustered, they are not necessarily sequential.

Column Two: Suggestions for Learning and Teaching

This column offers a range of strategies from which teachers and students may choose. Suggested learning experiences can be used in various combinations to help students achieve an outcome or outcomes. It is not necessary to use all of these suggestions, nor is it necessary for all students to engage in the same learning experience.

Column Three: Suggestions for Assessment

These suggestions may be used to assess students' success in achieving the outcomes; they are linked to the Outcomes column and the Suggestions for Learning and Teaching column. The suggestions are only samples; for more information, read the section Assessing and Evaluating Student Learning.

Column Four: Resources

This column contains a variety of information related to the items in the other columns, including suggested resources, elaborations on strategies, successes, cautions, and definitions. A complete list of resources suggested for this course can be found in Appendix A: Resources.

Program Design and Components

Program Organization

As indicated previously, the mathematics curriculum is designed to support the Atlantic Canada Essential Graduation Learnings (EGLs). The curriculum is designed to significantly contribute to students meeting each of the six EGLs, with the communication and problem-solving EGLs relating particularly well with the curriculum's unifying ideas. (See the "Outcomes" section of the Foundation for the Atlantic Canada Mathematics Curriculum.) The foundation document then goes on to present student outcomes at key stages of the student's school experience.

This curriculum guide presents specific curriculum outcomes at individual grade levels. As illustrated in Figure 2, these outcomes represent the step-by-step means by which students work toward accomplishing the key-stage curriculum outcomes, the general curriculum outcomes, and, ultimately, the essential graduation learnings.

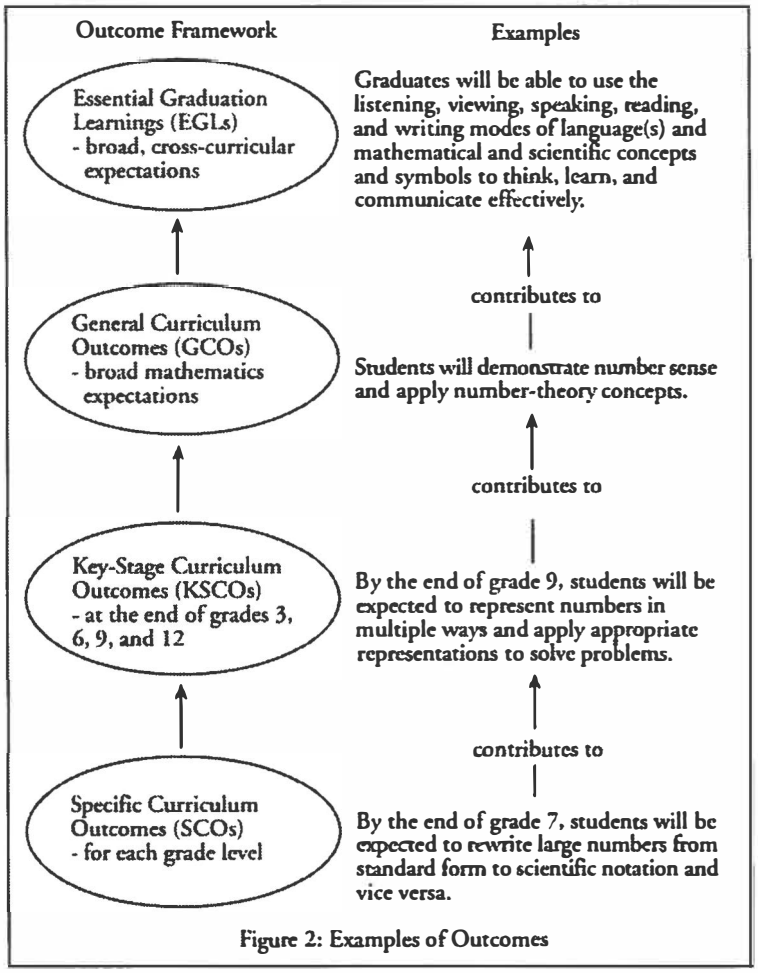


Figure 2: Examples of Outcomes

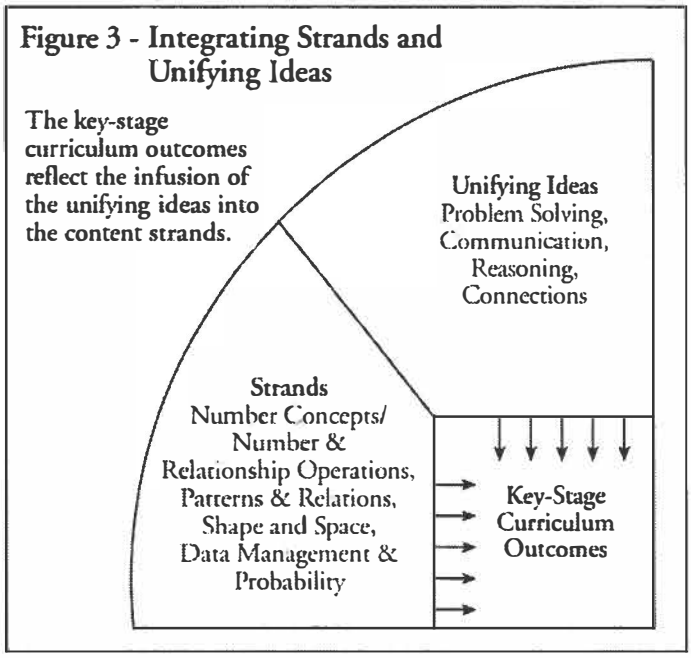
It is important to emphasize that the presentation of the specific curriculum outcomes at each grade level follows the outcome structure established in the Foundation for the Atlantic Canada Mathematics Curriculum and does not necessarily represent a natural teaching sequence. While some outcomes will of necessity need to be addressed before others due to prerequisite skill requirements, a great deal of flexibility exists as to the structuring of the program. As well, some outcomes (e.g. Patterns and Data Management) may be best addressed on an on-going basis in connection with other topics. It is expected that teachers will make individual decisions as to what sequence of topics/outcomes will best suit their classes. In most instances, this will occur in consultation with fellow staff members, department heads, and/or district level personnel.

Decisions on sequencing will depend on a number of factors, including the nature and interests of the students themselves. For instance, what might serve well as a "kickoff" topic for one group of students might be less effective in that role with a second group. Another consideration with respect to sequencing will be co-ordinating the mathematics program with other aspects of the students' school experience. Examples of such co-ordination include studying aspects of measurement in connection with appropriate topics in science, data management with a social studies issue, and some aspect of geometry with some physical education unit. As well, sequencing could be influenced by other events outside of the school, such as elections, special community celebrations, or natural occurrences.

Unifying Ideas

The NCTM Curriculum and Evaluation Standards establishes mathematical problem solving, communication, reasoning, and connections as central elements of the mathematics curriculum. The Foundation for the Atlantic Canada Mathematics Curriculum (pp. 7-11) further emphasizes these unifying ideas and presents them as being integral to all aspects of the curriculum. Indeed, while the general curriculum outcomes are organized around content strands, every opportunity has been taken to infuse the key-stage curriculum outcomes with one or more of the unifying ideas. This is illustrated in Figure 3.

These unifying concepts serve to link the content to methodology. They make it clear that mathematics is to be taught in a problem-solving mode; classroom activities and student assignments must be structured so as to provide opportunities for students to communicate mathematically; via teacher encouragement and questioning, students must explain and clarify their mathematical reasoning; and mathematics with which students are involved on a day-to-day basis must be connected to other mathematics, other disciplines, and/or the world around them.



Students will be expected to address routine and/or non-routine mathematical problems on a daily basis. Over time, numerous problem-solving strategies should be modelled for students, and students should be encouraged to employ various strategies in many problem-solving situations. While choices with respect to the timing of the introduction of any given strategy will vary, strategies such as try-and-adjust, look for a pattern, draw a picture, act it out, use models, make a table or chart, and make an organized list should all become familiar to students during their early years of schooling, whereas working backward, logical reasoning, trying a simpler problem, changing point of view, and writing an open sentence or equation would be part of a student's repertoire in the later elementary years. In grades 7-9, this repertoire will be extended to include such strategies as interpreting formulas, checking for hidden assumptions, examining systematic or critical cases, and solving algebraically.

Opportunities should be created frequently to link mathematics and career opportunities. During these important transitional years, students need to become aware of the importance of mathematics and the need for mathematics in so many career paths. This realization will help maximize the number of students who strive to develop and maintain the mathematical abilities required for success in higher-level mathematics programming in senior high mathematics and beyond.

Learning and Teaching Mathematics

The unifying ideas of the mathematics curriculum suggest quite clearly that the mathematics classroom needs to be one in which students are actively engaged each day in the doing of mathematics. No longer is it sufficient or proper to view mathematics as a set of concepts and algorithms for the teacher to transmit to students. Instead, students must come to see mathematics as a vibrant and useful tool for helping them understand their world, and as a discipline which lends itself to multiple strategies, student innovation, and, quite often, multiple solutions. (See the "Contexts for Learning and Teaching" section of the foundation document.)

The learning environment will be one in which students and teachers make regular use of manipulative materials and technology, and actively participate in discourse and conjecture, verify reasoning, and share solutions. This environment will be one in which respect is given to all ideas in which reasoning and sense making are valued above "getting the right answer." Students will have access to a variety of learning resources, will balance the acquisition of procedural skills with attaining conceptual understanding, will estimate routinely to verify the reasonableness of their work, will compute in a variety of ways while continuing to place emphasis on basic mental computation skills, and will engage in homework as a useful extension of their classroom experiences.

Adapting to the Needs of All Learners

The Foundation for the Atlantic Canada Mathematics Curriculum stresses the need to deal successfully with a wide variety of equity and diversity issues. Not only must teachers be aware of, and adapt instruction to account for, differences in student readiness as they enter the intermediate setting and as they progress, but they must also remain aware of avoiding gender and cultural biasses in their teaching. Ideally, every student should find his/her learning opportunities maximized in the mathematics classroom.

The reality of individual student differences must not be ignored when making instructional decisions. While this curriculum guide presents specific curriculum outcomes for each grade level, it must be acknowledged that all students will not progress at the same pace and will not be equally positioned with respect to attaining any given outcome at any given time. The specific curriculum outcomes represent, at best, a reasonable framework for assisting students to ultimately achieve the key-stage and general curriculum outcomes.

As well, teachers must understand, and design instruction to accommodate, differences in student learning styles. Different instructional modes are clearly appropriate, for example, for those students who are primarily visual learners versus those who learn best by doing. Further, the practice of designing classroom activities to support a variety of learning styles must be extended to the assessment realm; such an extension implies the use of a wide variety of assessment techniques, including journal writing, portfolios, projects, presentations, and structured interviews.

Support Resources

This curriculum guide represents the central resource for the teacher of mathematics for these grade levels. Other resources are ancillary to it. This guide should serve as the focal point for all daily, unit, and yearly planning, as well as a reference point to determine the extent to which the instructional outcomes should be met.

Nevertheless, other resources will be significant in the mathematics classroom. Textual and other print resources will be significant to the extent that they support the curriculum goals. Teachers will need professional resources as they seek to broaden their instructional and mathematical skills. Key among these are the NCTM publications, including the Assessment Standards for School Mathematics, Curriculum and Evaluation Standards for School Mathematics, the Grades 5-8 Addenda Series,

Professional Standards for Teaching Mathematics, and the various NCTM yearbooks. As well, manipulative materials and appropriate access to technological resources (e.g. software, videos) should be available. Calculators will be an integral part of many learning activities.

Role of Parents

Societal change dictates that students' mathematical needs today are in many ways different than were those of their parents. These differences are manifested not only with respect to mathematical content, but also with respect to instructional approach. As a consequence, it is important that educators take every opportunity to discuss with parents changes in mathematical pedagogy and why these changes are significant. Parents who understand the reasons for changes in instruction and assessment will be better able to support their children in mathematical endeavours by fostering positive attitudes towards mathematics, stressing the importance of mathematics in their children's lives, assisting children with mathematical activities at home, and, ultimately, helping to ensure that their children become confident, independent learners of mathematics.

Connections across the Curriculum

The teacher should take advantage of the various opportunities available to integrate mathematics and other subjects. This integration not only serves to show students how mathematics is used in daily life, but it helps strengthen the students' understanding of mathematical concepts and provides them with opportunities to practise mathematical skills. There are many possibilities for integrating learning experiences-through learning centres, teacher-directed activities, group or independent exploration, and other opportune learning situations. However, it should be remembered that certain aspects of mathematics are sequential, and need to be developed in the context of structured learning experiences.

The concepts and skills developed in mathematics are applied in many other disciplines. These include science, social studies, music, technology education, art, physical education, and home economics. Efforts should be made to make connections and use examples which apply across a variety of discipline areas.

In science, the concepts and skills of measurement are applied in the context of scientific investigations. Likewise, statistical concepts and skills are applied as students collect, present, and analyse data.

In social studies, measurement is used to read scale on a map, to measure land areas, and in various measures related to climatic conditions. As well, students read, interpret, and construct tables, charts, and graphs in a variety of contexts such as demography.

In addition, there are many opportunities to reinforce fraction concepts and operations in music, as well as opportunities to connect concepts such as symmetry and perspective drawings of art to aspects of 2-D and 3-D geometry.

Outcomes

Essential Graduation Learnings and Math for the Workplace 12

The Atlantic provinces have worked together to identify the abilities and areas of knowledge that they consider essential for students graduating from high school. These are referred to as Essential Graduation Learnings. Details may be found in the document Public School Programs.

Some examples of learning in Math for the Workplace 12 that help students move toward attainment of the Essential Graduation Learnings are given below.

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

By the end of Math for the Workplace 12, students will be expected to

- complete projects that are aesthetically pleasing to those in the field of study
- be aware of the specific aspects of their projects that are aesthetically interesting to both the instructor and their peers

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

By the end of Math for the Workplace 12, students will be expected to

- be aware of the current situation of our local and global employment opportunities through class discussion and focussed questions to skilled tradespeople

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s), as well as mathematical and scientific concepts and symbols, to think, learn, and communicate effectively.

By the end of Math for the Workplace 12, students will be expected to

- listen, view, speak, read, and write the mode of language that corresponds to their top rated career choice
- use text and to speak with skilled trades people in their field to improve upon these communication skills

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

By the end of Math for the Workplace 12, students will be expected to

- continue to learn about the necessary and appealing skills for them to be successful in their career choices

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

By the end of Math for the Workplace 12, students will be expected to

- solve practical problems that would arise in their career choices

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

By the end of Math for the Workplace 12, students will be expected to

- use a variety of tools that are required to solve problems and complete projects in their areas of career interest

Math for the Workplace 12 Curriculum Outcomes

Module 1: Measurement

GCO 1: Students will be expected to demonstrate a basic understanding of the mathematics required to complete measurement problems found in various trades.

By the end of this module, students will be expected to

- demonstrate an understanding of the meaning and uses of accuracy and precision
- use a measuring tape to measure tactile items in both imperial and SI units
- identify the difference between length, area, and volume
- demonstrate an understanding of the meaning and uses of significant figures
- demonstrate an understanding of and be able to solve problems using dimensional analysis
- identify, use, and convert among and between SI units and imperial units to measure and solve measurement problems
- estimate distances by using a personal benchmark such as walking pace
- demonstrate an understanding of and be able to solve problems using the Pythagorean theorem

Module 2: Mathematics in the Workplace Investigation

GCO 2: Students will be expected to demonstrate a basic understanding of the mathematics required for three different career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a guided mini-project.

By the end of this module, students will be expected to

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades
- demonstrate to others what type of mathematical knowledge is required to be successful at various career choices
- demonstrate entry-level competence in the mathematics associated with the specific career choice a student has made
- sketch and construct a model that will enable a student to show others some mathematics involved in a career interest

Module 3: Ratio, Rate, and Proportion

GCO 3: Students will be expected to demonstrate an understanding of ratio, rate, and proportion as they apply to specific career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

By the end of this module, students will be expected to

- calculate the dimensions of actual objects using blueprints with various scales
- sketch and build representations of three-dimensional objects using a variety of materials and information about the objects
- illustrate, explain, and express ratios, fractions, decimals, and percentages in alternative forms
- find and calculate rates in practical applications such as pulse rate
- estimate and calculate deductions taken from a pay stub as percentages of gross earnings
- sketch enlargements and reductions of objects using various scales
- use the slope formula to solve trigonometric problems commonly found in industry

Module 4: Major Project: Math Preparation for the Workplace

GCO 4: Students will be expected to demonstrate a strong understanding of the mathematics required for one career choice such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a major project.

By the end of this module, students will be expected to

- demonstrate to others what type of mathematical knowledge is required to be successful their career choices
- demonstrate competence in the mathematics associated with the specific career choice a student has made
- prepare a detailed blueprint for and construct a model that will enable a student to show others some mathematics involved in a specific career interest
- visit a post-secondary institution that teaches the trade of interest for each student
- visit a job-site situation that will provide an example of the career that each student has chosen to pursue

Module 1: Measurement

GCO 1: Students will be expected to demonstrate a basic understanding of the mathematics required to complete measurement problems found in various trades.

Outcomes

By the end of this module, students will be expected to

- demonstrate an understanding of the meaning and uses of accuracy and precision
- use a measuring tape to measure tactile items in both imperial and SI units
- identify the difference between length, area, and volume
- demonstrate an understanding of the meaning and uses of significant figures
- demonstrate an understanding of and be able to solve problems using dimensional analysis
- identify, use, and convert among and between SI units and imperial units to measure and solve measurement problems
- estimate distances by using a personal benchmark such as walking pace
- demonstrate an understanding of and be able to solve problems using the Pythagorean theorem

Suggestions for Learning and Teaching

Teachers can

- ensure that students take active roles in finding measurement items
- initiate discussion on how accuracy and precision differ and are trade related
- ensure participation of all students through team making and choice in the assignment of roles
- arrange for students to use the appropriate and available working spaces, such as the soccer field when completing certain tasks, such as Lesson Plan 6 in Module 1
- ensure that all students use the measurement tools that their career interests will utilize
- using the *Practical Problems in Mathematics* series, develop entry level knowledge of vocabulary that students may require in the career of their interest
- ensure that students come across situations that require measurements in both imperial and SI units

Students can

- brainstorm on how different careers utilize mainly lengths, other careers deal significantly with area, and still others use volume in many tasks in their daily work
- identify areas in several careers that utilize precision and accuracy
- use a measuring tape to measure many items in the classroom including their ow heights in both imperial and SI units
- discuss with a tradesperson how significant figures are used in daily work

GCO 1: Students will be expected to demonstrate a basic understanding of the mathematics required to complete measurement problems found in various trades.

Suggestions for Assessment

Teachers can

- work with students to develop portfolios throughout the course
- through observation and discussion, assess the students' use of trade-specific terminology and note their improvement throughout the course
- examine student portfolios for inclusion of appropriate materials

Students can

- engage in discussion and a comparison of their own and others' measurements when using the same object
- create reflective journals with notes, comments, questions, sketches, and plans for each aspect of the course
- engage in co-operative exercises that demonstrate an understanding of working as part of a construction/production team with students accepting different roles
- develop time and activity schedules/calendars for completion of assignments, tasks, and projects

Resources

One of the major challenges to teachers is having students who are interested in numerous skilled trades. However, proper use of the suggested resources and grouping students who have similar career interests will makes teaching more manageable. When doing many number and operation-type outcomes, teachers can utilize the following resources to have students do problems that are meaningful to them.

- *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005)
- *Practical Problems in Mathematics for Drafting and CAD* (Larkin (2005)
- *Practical Problems in Mathematics for Welders* (Schell and Matlock 1996)
- *Practical Problems in Mathematics for Health Occupations* (Simmers 2005)
- *Practical Problems in Mathematics for Graphic Communications* (Dennis, Vermeersch, and Southwick 1998)
- *Practical Problems in Mathematics for Electricians* (Herman 2005)
- *Practical Problems in Mathematics for Heating and Cooling Technicians* (DeVore 2005)
- *Practical Problems in Mathematics for Industrial Technology* (Boatwright 1996)

GCO 1: Students will be expected to demonstrate a basic understanding of the mathematics required to complete measurement problems found in various trades.

Outcomes

By the end of this module, students will be expected to

- demonstrate an understanding of the meaning and uses of accuracy and precision
- use a measuring tape to measure tactile items in both imperial and SI units
- identify the difference between length, area, and volume
- demonstrate an understanding of the meaning and uses of significant figures
- demonstrate an understanding of and be able to solve problems using dimensional analysis
- identify, use, and convert among and between SI units and imperial units to measure and solve measurement problems
- estimate distances by using a personal benchmark such as walking pace
- demonstrate an understanding of and be able to solve problems using the Pythagorean theorem

Suggestions for Learning and Teaching

Students can

- use dimensional analysis to solve problems that have a number and a unit
- find conversion charts using the Internet to aid in using dimensional analysis to solve problems among and between imperial and SI units
- identify the uses of knowing walking pace in practical applications
- identify the relationships that exist when solving problems involving a right angled triangle
- research types of careers that they may find interesting
- develop portfolios such as the Life Work Portfolio to aid in moving toward specific career choices
- investigate the Internet and sites such as Workit or Career Options to help determine if their interests may lead to skilled trades

GCO 1: Students will be expected to demonstrate a basic understanding of the mathematics required to complete measurement problems found in various trades.

Suggestions for Assessment

Teachers can

- work with students to develop portfolios throughout the course
- through observation and discussion, assess the students' use of trade specific terminology and note their improvement throughout the course
- examine student portfolios for inclusion of appropriate materials

Students can

- discuss and compare their own and others' measurements when using the same object
- create reflective journals with notes, comments, questions, sketches, and plans for each aspect of the course
- engage in co-operative exercises that demonstrate an understanding of working as part of a construction/production team with students accepting different roles
- develop time and activity schedules/calendars for completion of assignments, tasks, and projects

Resources

- *Practical Problems in Mathematics for Automotive Technicians* (Moore, Sformo, and Sformo 2005)
- *Practical Problems in Mathematics for Emergency Services* (Sturtevant 2000)
- *Practical Problems in Mathematics for Manufacturing* (Davis 1995)
- *Practical Problems in Mathematics for Electronic Technicians* (Herman 2004)
- *Practical Problems in Mathematics for Carpenters* (Huth and Huth 2006)
- *Practical Problems in Mathematics for Masons* (Ball 1980)
- *Basic Technical Mathematics: A sourcebook for applications.* (Miles 1989)

Module 2: Mathematics in the Workplace Investigation

GCO 2: Students will be expected to demonstrate a basic understanding of the mathematics required for three different career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a guided mini-project.

Outcomes

By the end of this module, students will be expected to:

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades
- demonstrate to others what type of mathematical knowledge is required to be successful at various career choices
- demonstrate entry-level competence in the mathematics associated with the specific career choice a student has made
- sketch and construct a model that will enable a student to show others some mathematics involved in a career interest

Suggestions for Learning and Teaching

Teachers can

- ensure that students take active roles in the exploration of career opportunities using their interests as a guide
- encourage the development of interpersonal skills through practice of an interview situation
- ensure that students have questions ready for the interview that relate to the mathematics of their career explorations
- using the *Practical Problems in Mathematics* series, develop entry-level knowledge of vocabulary that students may require in their careers of interest so they can ask specific questions at their interviews
- provide information and discuss how an interview situation has its own etiquette
- ensure that students come across situations that require measurements in both imperial and SI units
- arrange for a tradesperson to speak to the class and share his or her experiences
- engage visiting resource people in discussions with students on how they use mathematics every day in their careers
- suggest a time schedule for students to follow when completing the longer term project

GCO 2: Students will be expected to demonstrate a basic understanding of the mathematics required for three different career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a guided mini-project.

Suggestions for Assessment

Teachers can

- meet with teams/individuals to provide expectations and gather feedback
- identify and address individual/team concerns as they arise throughout the project
- assign specific tasks to be carried out during each phase of the project and assess the level of participation and achievement by the students
- view projects with students, providing formal/ informal feedback
- assist students in designing timetables, work schedules, and realistic project timelines
- interview each individual/team at key points during the project
- provide ongoing opportunities for students to talk and write about their experiences dealing with skilled tradespeople
- develop charts, checklists, schedules, and survey forms to help students structure their learning from field trips and job-shadowing experiences
- negotiate appropriate choices in student selection of interest areas
- assist students regularly in assessing their own progress, evaluating their learning, and setting goals for themselves by providing regular feedback
- lead the students in reflective activities in which they discuss their responses among themselves
- develop with students profiles of their work, questions, comments, and concerns
- create opportunities to celebrate student work within the school and community
- examine student portfolios for inclusion of appropriate materials

Resources

The following resources will aid in the daily delivery and practice of basic mathematics skills that are required in many careers discussed in this course:

- *Mastering Essential Math Skills* (Fisher 1998).
- *Mental Math in Junior High* (Hope, Reys, and Reys 1988)

GCO 2: Students will be expected to demonstrate a basic understanding of the mathematics required for three different career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a guided mini-project.

Outcomes

By the end of this module, students will be expected to:

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades
- demonstrate to others what type of mathematical knowledge is required to be successful at various career choices
- demonstrate entry-level competence in the mathematics associated with the specific career choice a student has made
- sketch and construct a model that will enable a student to show others some mathematics involved in a career interest

Suggestions for Learning and Teaching

Students can

- explore post-secondary programs that provide training and apprenticeship routes to become skilled tradespeople
- research types of careers that they may find interesting
- develop portfolios such as the Life Work Portfolio to aid in moving toward specific career choices
- investigate the Internet and sites such as Workit or Career Options to help determine if their interests may lead to skilled trades
- discuss with a tradesperson on how mathematics is used in their daily work
- report to the class or smaller groups within the class on the information gained from an interview with a skilled tradesperson
- ask questions to other classmates who interviewed a person in a trade that may be quite different to the trades that they were interested in

GCO 2: Students will be expected to demonstrate a basic understanding of the mathematics required for three different career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a guided mini-project.

Suggestions for Assessment

Students can

- provide constructive collaborative feedback to other team members and the class during and following the interview with a skilled tradesperson
- do oral and written presentations on their chosen career choices
- maintain reflective journals with notes, comments, questions, sketches, and plans for each aspect of the course
- engage in co-operative exercises that demonstrate an understanding of working as part of a construction/production team with students accepting different roles
- develop time and activity schedules/calendars for completion of assignments, tasks, and projects
- maintain portfolios that highlight their most likely career choices, including learning logs, schedules, charts, artifacts, projects, research, field notes, and self-assessment records
- assess success of adherence to timetables, schedules, and deadlines

Resources

The following resources will aid in the daily delivery and practice of basic mathematics skills that are required in many careers discussed in this course:

- *Mastering Essential Math Skills* (Fisher 1998).
- *Mental Math in Junior High* (Hope, Reys, and Reys 1988)

Module 3: Ration, Rate and Proportion

GCO 3: Students will be expected to demonstrate an understanding of ratio, rate, and proportion as they apply to specific career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

Outcomes

By the end of this module, students will be expected to

- calculate the dimensions of actual objects using blueprints with various scales
- sketch and build representations of three-dimensional objects using a variety of materials and information about the objects
- illustrate, explain, and express ratios, fractions, decimals, and percentages in alternative forms
- find and calculate rates in practical applications such as pulse rate
- estimate and calculate deductions taken from a pay stub as percentage of gross earnings
- sketch enlargements and reductions of objects using various scales
- use the slope formula to solve trigonometric problems commonly found in industry

Suggestions for Learning and Teaching

Teachers can

- ensure that students take an active role in finding blueprints that are particularly interesting to them or their classmates
- ensure participation of all students through team making and choice in the assignment of roles
- arrange for students to have access to the appropriate and available staff such as when working on sketching and building representations of three-dimensional objects
- provide information on how certain deductions are standard for any employee of a company
- ensure that students come across situations that require measurements in both imperial and SI units when completing problems with ratios, fractions, decimals, and percentages
- continue to monitor students as they develop portfolios such as the Life Work Portfolio to aid in moving toward specific career choices

GCO 3: Students will be expected to demonstrate an understanding of ratio, rate, and proportion as they apply to specific career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

Suggestions for Assessment

Teachers can

- provide ongoing opportunities for students to show their mathematical knowledge in key areas
- through observation and discussion, assess the students' use of trade-specific terminology and note their improvement since the start of the course
- develop time and activity schedules/calendars for completion of assignments, tasks, and projects
- invite a post-secondary educator such as a community college instructor to the class to discuss how a project is evaluated at their institution
- examine student portfolios for inclusion of appropriate materials

Resources

One of the major challenges to teachers is having students who are interested in numerous skilled trades. However, with proper use of the suggested resources and by grouping students with similar career interests, it makes teaching more manageable. When doing many number- and operation-type outcomes, teachers can utilize the following resources to have students do problems that are meaningful to them.

- *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005)
- *Practical Problems in Mathematics for Drafting and CAD* (Larkin 2005)
- *Practical Problems in Mathematics for Welders* (Schell and Matlock 1996)
- *Practical Problems in Mathematics for Health Occupations* (Simmers 2005)
- *Practical Problems in Mathematics for Graphic Communications* (Dennis, Vermeersch and Southwick 1998)
- *Practical Problems in Mathematics for Electricians* (Herman 2005)
- *Practical Problems in Mathematics for Heating and Cooling Technicians* (DeVore 2005)
- *Practical Problems in Mathematics for Industrial Technology* (Boatwright 1996)

GCO 3: Students will be expected to demonstrate an understanding of ratio, rate, and proportion as they apply to specific career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

Outcomes

By the end of this module, students will be expected to

- calculate the dimensions of actual objects using blueprints with various scales
- sketch and build representations of three-dimensional objects using a variety of materials and information about the objects
- illustrate, explain, and express ratios, fractions, decimals, and percentages in alternative forms
- find and calculate rates in practical applications such as pulse rate
- estimate and calculate deductions taken from a pay stub as percentage of gross earnings
- sketch enlargements and reductions of objects using various scales
- use the slope formula to solve trigonometric problems commonly found in industry

Suggestions for Learning and Teaching

Students can

- continue to use dimensional analysis to solve problems that have a number and a unit
- find conversion charts using the Internet to aid in using dimensional analysis to solve problems among and between imperial and SI units
- identify the relationships that exist when solving problems involving a right-angled triangle
- begin to use industry terminology when asking questions to the teacher or other class members
- continue to research types of careers that they may find interesting, narrowing the focus as the course continues
- continue to develop portfolios such as the Life Work Portfolio to aid in moving toward specific career choices

GCO 3: Students will be expected to demonstrate an understanding of ratio, rate, and proportion as they apply to specific career choices such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

Suggestions for Assessment

Students can

- engage in self-assessment through task checklists, journal entries, notes, schedules, and presentations
- create detailed blueprints, working through several drafts
- maintain reflective journals with notes, comments, questions, sketches, and plans for each aspect of the course
- develop time and activity schedules/calendars for completion of assignments, tasks, and projects

Resources

- *Practical Problems in Mathematics for Automotive Technicians* (Moore, Sformo, and Sformo 2005)
- *Practical Problems in Mathematics for Emergency Services* (Sturtevant 2000)
- *Practical Problems in Mathematics for Manufacturing* (Davis 1995)
- *Practical Problems in Mathematics for Electronic Technicians* (Herman 2004)
- *Practical Problems in Mathematics for Carpenters* (Huth and Huth 2006)
- *Practical Problems in Mathematics for Masons* (Ball 1980)
- *Basic Technical Mathematics: A sourcebook for applications* (Miles 1989)
- *Mathematics: Continuum* (Belanger 2002)

Module 4: Major Project: Math Preparation for the Workplace

GCO 4: Students will be expected to demonstrate a strong understanding of the mathematics required for one career choice such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a major project.

Outcomes

By the end of this module, students will be expected to

- demonstrate to others what type of mathematical knowledge is required to be successful in their career choices
- demonstrate competence in the mathematics associated with the specific career choice student has made
- prepare a detailed blueprint for and construct a model that will enable a student to show others some mathematics involved in a specific career interest
- visit a post-secondary institution that teaches the trade of interest for each student
- visit a job-site situation that will provide an example of the career that each student has chosen to pursue

Suggestions for Learning and Teaching

Teachers can

- encourage students to take an active role in finding opportunities to experience the careers they have chosen through summer employment or volunteer positions as casual help
- ensure participation of all students through team making and choice in the assignment of roles
- arrange for students to use the appropriate and available working spaces such as the general shop, when completing certain tasks, such as their major projects
- ensure that students are aware of some of the tools that their career interests will utilize
- using the Practical Problems in Mathematics series, continue to develop entry-level knowledge of vocabulary that students may require in the career of their interest
- arrange for the class to spend a day at a local community college to "test drive" the programs that they find interesting
- ensure that students continue to solve problems that require measurements in both imperial and SI units
- suggest a time schedule for students to follow when completing the longer term project

GCO 4: Students will be expected to demonstrate a strong understanding of the mathematics required for one career choice such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a major project.

Suggestions for Assessment

Teachers can

- meet with teams/individuals to provide expectations and gather feedback
- identify and address individual/team concerns as they arise throughout the project
- assign specific tasks to be carried out during each phase of the project and assess the level of participation and achievement by the students
- view projects with students, providing formal/ informal feedback
- assist students in designing timetables, work schedules, and realistic project timelines
- interview each individual/team at key points during the project
- negotiate appropriate choices in student selection of interest areas
- assist students regularly in assessing their own progress, evaluating their learning, and setting goals for themselves by providing regular feedback
- lead the students in reflective activities in which they discuss their responses among themselves
- meet with teams/individuals to provide expectations and gather feedback
- develop with students profiles of their work, questions, comments, and concerns
- examine student portfolios for inclusion of appropriate materials
- create opportunities to celebrate student work within the school and community

Resources

The following resources will aid in the daily delivery and practice of basic mathematics skills that are required in many careers discussed in this course:

- *Mastering Essential Math Skills* (Fisher 1998).
- *Mental Math in Junior High* (Hope, Reys, and Reys 1988)

GCO 4: Students will be expected to demonstrate a strong understanding of the mathematics required for one career choice such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technolog marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a major project.

Outcomes

By the end of this module, students will be expected to

- demonstrate to others what type of mathematical knowledge is required to be successful in their career choices
- demonstrate competence in the mathematics associated with the specific career choice student has made
- prepare a detailed blueprint for and construct a model that will enable a student to show others some mathematics involved in a specific career interest
- visit a post-secondary institution that teaches the trade of interest for each student
- visit a job-site situation that will provide an example of the career that each student has chosen to pursue

Suggestions for Learning and Teaching

Students can

- continue to use dimensional analysis to solve problems that have a number and a unit
- continue to use conversion charts to aid in solving problems among and between imperial and SI units
- research types of careers that they may find interesting
- develop portfolios such as the Life Work Portfolio to aid in moving toward specific career choices
- communicate with friends who have been involved with their career interests to gain some new insights

GCO 4: Students will be expected to demonstrate a strong understanding of the mathematics required for one career choice such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry through a major project.

Suggestions for Assessment

Students can

- maintain reflective journals with notes, comments, questions, sketches, and plans for each aspect of the course
- develop time and activity schedules/calendars for completion of assignments, tasks, and projects
- maintain portfolios that highlight their chosen career choices, including learning logs, schedules, charts, artifacts, projects, research, field notes, and self-assessment records
- present profiles of tradespeople who have had some influence on their career choices
- assess success of adherence to timetables, schedules, and deadlines

Resources

The following resources will aid in the daily delivery and practice of basic mathematics skills that are required in many careers discussed in this course:

- *Mastering Essential Math Skills* (Fisher 1998).
- *Mental Math in Junior High* (Hope, Reys, and Reys 1988)

Contexts for Learning and Teaching

Principles of Learning

The public school program is based on principles of learning that teachers and administrators should use as the basis for the experiences they plan for their students. These principles include the following.

Learning is a process of actively constructing knowledge.

Therefore, teachers and administrators have a responsibility to

- create environments and plan experiences that foster inquiry, questioning, predicting, exploring, collecting, educational play, and communicating
- engage learners in experiences that encourage their personal construction of knowledge, for example, hands-on, minds-on science and math; drama; creative movement; artistic representation; writing and talking to learn
- provide learners with experiences that actively involve them and are personally meaningful

Students construct knowledge and make it meaningful in terms of their prior knowledge and experiences.

Therefore, teachers and administrators have a responsibility to

- find out what students already know and can do
- create learning environments and plan experiences that build on learners' prior knowledge
- ensure that learners are able to see themselves reflected in the learning materials used in the school
- recognize, value, and use the great diversity of experiences and information students bring to school
- provide learning opportunities that respect and support students' racial, cultural, and social identities
- ensure that students are invited or challenged to build on prior knowledge, integrating new understandings with existing understandings

Learning is enhanced when it takes place in a social and collaborative environment.

Therefore, teachers and administrators have a responsibility to

- ensure that talk, group work, and collaborative ventures are central to class activities
- see that learners have frequent opportunities to learn from and with others
- structure opportunities for learners to engage in diverse social interactions with peers and adults
- help students to see themselves as members of a community of learners

Students need to continue to view learning as an integrated whole.

Therefore, teachers and administrators have a responsibility to

- plan opportunities to help students make connections across the curriculum and with the world outside and structure activities that require students to reflect on those connections
- invite students to apply strategies from across the curriculum to solve problems in real situations

Learners must see themselves as capable and successful.

Therefore, teachers and administrators have a responsibility to

- provide activities, resources, and challenges that are developmentally appropriate to the learners
- communicate high expectations for achievement to all students
- encourage risk taking in learning
- ensure that all students experience genuine success on a regular basis
- value experimentation and treat approximation as signs of growth
- provide frequent opportunities for students to reflect on and describe what they know and can do
- provide learning experiences and resources that reflect the diversity of the local and global community
- provide learning opportunities that develop self-esteem

Learners have different ways of knowing and representing knowledge.

Therefore, teachers and administrators have a responsibility to

- recognize each learner's preferred ways of constructing meaning and provide opportunities for exploring alternative ways
- plan a wide variety of open-ended experiences and assessment strategies
- recognize, acknowledge, and build on students' diverse ways of knowing and representing their knowledge
- structure frequent opportunities for students to use various art forms—music, drama, visual arts, dance, movement, crafts—as a means of exploring, formulating, and expressing ideas

Reflection is an integral part of learning.

Therefore, teachers and administrators have a responsibility to

- challenge their beliefs and practices based on continuous reflection
- reflect on their own learning processes and experiences
- encourage students to reflect on their learning processes and experiences
- encourage students to acknowledge and articulate their learnings
- help students use their reflections to understand themselves as learners, make connections with other learnings, and proceed with learning

A Variety of Learning Styles and Needs

Learners have many ways of learning, knowing, understanding, and creating meaning. Research into links between learning styles and preferences and the physiology and function of the brain has provided educators with a number of helpful concepts of and models for learning. Howard Gardner, for example, identifies eight broad frames of mind or intelligences: linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, musical, interpersonal, intrapersonal, and naturalistic. Gardner believes that each learner has a unique combination of strengths and weaknesses in these eight areas, but that the intelligences can be more fully developed through diverse learning experiences. Other researchers and education psychologists use different models to describe and organize learning preferences.

Students' ability to learn is also influenced by individual preferences and needs within a range of environmental factors, including light, temperature, sound levels, nutrition, proximity to others, opportunities to move around, and time of day.

How students receive and process information and the ways they interact with peers and their environment, in specific contexts, are both indicators and shapers of their preferred learning styles. Most learners have a preferred learning style, depending on the situation and the type and form of information the student is dealing with, just as most teachers have a preferred teaching style, depending on the context. By reflecting on their own styles and preferences as learners and as teachers in various contexts, teachers can

- build on their own teaching-style strengths
- develop awareness of and expertise in a number of learning and teaching styles and preferences
- identify differences in student learning styles and preferences
- organize learning experiences to accommodate the range of ways in which students learn, especially students for whom the range of ways of learning is limited

Learning experiences and resources that engage students' multiple ways of understanding allow them to become aware of and reflect on their learning processes and preferences. To enhance their opportunities for success, students need

- a variety of learning experiences to accommodate their diverse learning styles and preferences
- opportunities to reflect on their preferences and the preferences of others to understand how they learn best and that others may learn differently
- opportunities to explore, apply, and experiment with learning styles other than those they prefer, in learning contexts that encourage risk taking
- opportunities to return to preferred learning styles at critical stages in their learning
- opportunities to reflect on other factors that affect their learning, for example, environmental, emotional, sociological, cultural, and physical factors
- a time line appropriate for their individual learning needs within which to complete their work

The Senior High School Learning Environment

Creating Community

To establish the supportive environment that characterizes a community of learners, teachers need to demonstrate that they value all learners, illustrating how diversity enhances the learning experiences of all students; for example, by emphasizing courtesy in the classroom through greeting others by name, thanking them for answers, and inviting, rather than demanding, participation. Students could also be encouraged to share interests, experiences, and expertise with one another.

Students must know one another in order to take learning risks, make good decisions about their learning, and build the base for peer partnerships for tutoring, sharing, co-operative learning, and other collaborative learning experiences.

Through mini-lessons, workshops, and small-group dynamic activities during initial classes, knowledge is shared about individual learning styles, interpersonal skills, and team building.

The teacher should act as a facilitator, attending to both active and passive students during group activities, modelling ways of drawing everyone into the activity, as well as ways of respecting and valuing each person's contributions, and identifying strengths and needs for future conferences on an individual basis.

Having established community within the classroom, the teacher and students together can make decisions about learning activities. Whether students are working as a whole class, in small groups, in pairs, in triads, or individually, teachers should

- encourage comments from all students during whole-class discussion, demonstrating confidence in and respect for their ideas
- guide students to direct questions evenly to members of the group
- encourage students to discover and work from the prior knowledge in their own social, racial, or cultural experiences
- encourage questions, never assuming prior knowledge
- select partners or encourage students to select different partners for specific purposes
- help students establish a comfort zone in small groups where they will be willing to contribute to the learning experience
- observe students during group work, identifying strengths and needs, and conference with individuals to help them develop new roles and strategies
- include options for students to work alone for specific and clearly defined purposes

Engaging All Students

A supportive environment is important for all learners and is especially important in encouraging disengaged or underachieving learners.

Math for the Workplace 12 provides new opportunities to engage students who lack confidence in themselves as learners, who have a potential that has not been realized, or whose learning has been interrupted. These students may need substantial support in gaining essential knowledge and skills and in interacting with others.

Students need to engage fully in learning experiences that

- are perceived as authentic and worthwhile
- build on their prior knowledge
- allow them to construct meaning in their own way, at their own pace
- link learning to understanding and affirming their own experiences
- encourage them to experience ownership and control of their learning
- feature frequent feedback and encouragement
- include opportunities to provide individuals with clarification and elaboration
- are not threatening or intimidating
- focus on successes rather than failures
- are organized into clear, structured segments

It is important that teachers design learning experiences that provide a balance between challenge and success and between support and autonomy.

All students benefit from a variety of grouping arrangements that allow optimum opportunities for meaningful teacher-student and student-student interaction. An effective instructional design provides a balance of the following grouping strategies:

- large-group or whole-class learning
- teacher-directed small-group learning
- small-group-directed learning
- co-operative learning groups
- one-to-one teacher-student learning
- independent learning
- partnered learning
- peer or cross-age tutoring
- mentoring

Health and Safety

Activities in Math for the Workplace 12 should include an element of safety education. Teachers should plan learning experiences with a specific safety focus and also embed safe practices in classroom procedures and routines in order that students may acquire

- a strong orientation toward both personal and group safety
- an awareness of potential safety hazards at school and in the workplace
- a knowledge of safety procedures and safe work habits
- a knowledge of emergency procedures
- the ability to design and maintain safe work areas

Although Math for the Workplace 12 does not include courses such as Occupational Healthand Safety, WHMIS, Emergency First Aid, CPR, or Workplace Safety, students in the course should be encouraged to apply to these courses if they are offered outside of school hours. Some are offered online, and others can be taken as day courses. Each of them offers support to students who may be visiting a workplace situation during this course.

More specific guidelines can be found on the Nova Scotia Department of Environment and Labour website.

Learning beyond the Classroom

Math for the Workplace 12 offers many opportunities for students to extend learning beyond the classroom. Alternative settings provide students with opportunities to connect their learning to tangible, practical purposes, their future education and career plans, and the world beyond the high school setting. Many activities in this curriculum require students to participate in their learning outside the traditional classroom, or even outside the school, and sometimes these activities take place outside the regular school day. Administrators should recognize that learning in this course may take place in non-traditional settings, and they should support teachers by ensuring that they are aware of proper protocol in these circumstances.

Teachers may choose to organize learning experiences that include workplace settings for some or all students. Learning experiences may include

- practices and procedures to encourage students to use technology properly and with care
- activities with mentors
- classroom visits from workplace experts
- field trips to local business, industry, and community sites
- a focus on career exploration through job shadowing
- work placements that extend and reinforce learning
- entrepreneurship-related projects
- community and service learning projects
- use of Internet listserv, newsgroup, bulletin board, and online conversations

It is important that administrators and teachers work to establish mutually beneficial relationships with businesses, organizations, and facilities that support students in the workplace. Class or group field trips are an effective way to initiate the contact. In organizing field trips teachers should

- visit the facility beforehand to identify potential safety issues, establish a relationship with personnel, and clarify the purposes of the trip
- establish class practices and procedures that promote positive and ongoing community relationships
- work with students to articulate clear expectations for learning during the field trip experience
- schedule field trips to complement preceding and subsequent classroom learning experiences
- ensure that the field trip complies with their board's guidelines and policies

Meeting the Needs of All Students

Learners require inclusive classrooms, where a wide variety of learning experiences ensures that all students have equitable opportunities to reach their potential.

In designing learning experiences, teachers must accommodate the learning needs of individuals and consider the abilities, experiences, interests, and values that they bring to the classroom.

In recognizing and valuing the diversity of students, teachers should consider ways to

- create a climate and design learning experiences to affirm the dignity and worth of all learners in the classroom community
- give consideration to the social and economic situations of all learners
- model the use of inclusive language, attitudes, and actions supportive of all learners
- acknowledge racial and cultural uniqueness
- adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address learners' needs and build on their strengths
- provide opportunities for learners to work in a variety of contexts, including mixed-ability groupings
- identify and utilize strategies and resources that respond to the range of students' learning styles and preferences
- build on students' individual levels of knowledge, skills, and attitudes
- design learning and assessment tasks that draw on learners' strengths
- use students' strengths and abilities to motivate and support their learning
- provide opportunities for students to make choices that will broaden their access to a range of learning experiences
- acknowledge the accomplishment of learning tasks, especially those that learners believed were too challenging for them

In a supportive learning environment, all students receive equitable access to resources, including the teacher's time and attention, technology, learning assistance, a range of roles in group activities, and choices of learning experiences when options are available. All students are disadvantaged when oral, written, and visual language creates, reflects, and reinforces stereotyping.

Teachers promote social, cultural, racial, and gender equity when they provide opportunities for students to critically examine the texts, contexts, and environments associated with Math for the Workplace 12 in the classroom, in the community, and in the media. Teachers should look for opportunities to

- promote critical thinking
- recognize knowledge as socially constructed
- model gender-fair language and respectful listening in all their interactions with students
- articulate high expectations for all students
- provide equal opportunity for input and response from all students
- encourage all students to assume leadership roles
- ensure that all students have a broad range of choice in learning and assessment tasks

- encourage students to avoid making decisions about roles and language choices based on stereotyping
- include the experiences and perceptions of all students in all aspects of their learning
- recognize the contributions of men and women of all social, cultural, linguistic, and racial backgrounds to all disciplines throughout history

Social and cultural diversity in student populations expand and enrich the learning experiences of all students. Students can learn much from the backgrounds, experiences, and perspectives of their classmates. In a community of learners, participants explore the diversity of their own and others' customs, histories, values, beliefs, languages, and ways of seeing and making sense of the world. When learning experiences are structured to allow for a range of perspectives, students from varied social and cultural backgrounds realize that their ways of seeing and knowing are not the only ones possible. They can come to examine more carefully the complexity of ideas and issues arising from the differences in their perspectives and understand how cultural and social diversity enrich their lives and their culture.

The curriculum outcomes designed for Math for the Workplace 12 provide a framework for a range of learning experiences for all students.

Teachers must adapt learning contexts, including environment, strategies for learning, and strategies for assessment, to provide support and challenge for all students, using learning outcomes to plan learning experiences appropriate to students' individual learning needs. When these changes are not sufficient for a student to meet designated outcomes, an individual program plan (IPP) is developed. For more detailed information, see Special Education Policy Manual (1996), Policy 2.6.

A range of learning experiences, teaching and learning strategies, resources, and environments provides expanded opportunities for all learners to experience success as they work toward the achievement of designated outcomes. Many of the learning experiences suggested in this guide provide access for a wide range of learners, simultaneously emphasizing both group support and individual activity. Similarly, the suggestions for a variety of assessment practices provide multiple ways for students to demonstrate their achievements.

In order to provide a range of learning experiences to challenge all students, teachers may adapt learning contexts to stimulate and extend learning. Teachers should consider ways in which students can extend their knowledge base, thinking processes, learning strategies, self-awareness, and insights. Some learners can benefit from opportunities to negotiate their own challenges, design their own learning experiences, set their own schedules, and work individually or with learning partners.

Some students' learning needs may be met by providing opportunities for them to focus on learning contexts that emphasize experimentation, inquiry, and critical and personal perspectives; in these contexts, teachers should work with students to identify and obtain access to appropriate resources.

Assessing and Evaluating Student Learning

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analysing, reflecting upon, and summarizing assessment information and making judgments or decisions based upon the information gathered.

The Principles of Assessment and Evaluation articulated in the document Public School Programs should be used as the basis of assessment and evaluation policies, procedures, and practices.

Effective Assessment and Evaluation Practices

Effective assessment improves the quality of learning and teaching. It can help students to become more reflective and to have control of their own learning, and it can help teachers to monitor and focus their instructional programs.

Assessment and evaluation of student learning should accommodate the complexity of learning and reflect the complexity of the curriculum. Evaluation should be based on the full range of learning outcomes towards which students have been working during the reporting period, should be proportionate to the learning experiences related to each outcome, and should focus on patterns of achievement as well as specific achievement.

In reflecting on the effectiveness of their assessment program, teachers should consider the extent to which their practices

- are fair in terms of the student's background or circumstances
- are integrated with learning
- provide opportunities for authentic learning
- focus on what students can do rather than on what they cannot do
- provide students with relevant, supportive feedback that helps them to shape their learning
- describe students' progress toward learning outcomes
- help them to make decisions about revising, supporting, or extending learning experiences
- support learning risk taking
- provide specific information about the processes and strategies students are using
- provide students with diverse and multiple opportunities to demonstrate their achievement
- provide evidence of achievement in which students can take pride
- acknowledge attitudes and values as significant learning outcomes
- encourage students to reflect on their learning and to articulate personal learning plans
- help them to make decisions about teaching strategies, learning experiences and environments, student grouping, and resources
- accommodate multiple responses and a range of tasks and resources
- include students in developing, interpreting, and reporting on assessment

Involving Students in the Assessment Process

When students are aware of the outcomes they are responsible for and the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate what they know, are able to do, and value.

It is important that students participate actively in the assessment and evaluation of their learning, developing their own criteria and learning to judge a range of qualities in their work. Students should have access to models in the form of scoring criteria, rubrics, and work samples.

As lifelong learners, students assess their own progress, rather than relying on external measures, for example, grades, to tell them how well they are doing. Students who are empowered to assess their own progress are more likely to perceive their learning as its own reward. Rather than asking, What does the teacher want? students need to ask questions such as, What have I learned? What can I do now that I couldn't do before? What do I need to learn next?

Effective assessment practices provide opportunities for students to

- reflect on their progress toward learning outcomes
- assess and evaluate their learning
- set goals for future learning

Diverse Learning Styles and Needs

Teachers should develop assessment practices that affirm and accommodate students' cultural and linguistic diversity. Teachers should consider patterns of social interaction, diverse learning styles, and the multiple ways in which oral, written, and visual language are used in different cultures for a range of purposes. Student performance takes place not only in a learning context, but in a social and cultural context as well.

Assessment practices must be fair, equitable, and without bias, creating opportunities for students who have had a range of learning opportunities and experiences to demonstrate their learning.

Teachers should be flexible in evaluating the learning success of students and seek diverse ways for students to demonstrate their personal best. In inclusive classrooms, students with special needs have opportunities to demonstrate their learning in their own way, using media that accommodate their needs, and at their own pace.

Using a Variety of Assessment Strategies

When teachers make decisions about what learning to assess and evaluate, how to assess and evaluate, and how to communicate the results, they send clear messages to students and others about what learning they value; for example, teachers can communicate that they value risk taking or lateral thinking by including these elements in determining marks or grades.

Assessment involves the use of a variety of methods to gather information about a wide range of student learning to develop a valid and reliable snapshot of what students know and are able to do that is clear, comprehensive, and balanced. The assessment process provides information about each student's progress toward achievement of learning outcomes, which teachers can use to assign grades, to initiate conversations with students, or to make decisions in planning subsequent learning experiences.

Teachers align assessment and evaluation practices with student-centred learning practices when they

- design evaluation and assessment tasks that help students make judgments about their own learning and performance
- provide evaluation and assessment tasks that allow for a variety of learning styles and preferences
- individualize evaluation and assessment tasks to accommodate specific learning needs
- work with students to describe and clarify what will be evaluated and how it will be evaluated
- provide students with feedback on their learning that is regular, specific, frequent, and consistent

Assessment activities, tasks, and strategies include, for example,

- anecdotal records
- artifacts
- audiotapes
- checklists
- certifications
- conferences
- demonstrations
- dramatizations
- exhibitions
- interviews (structured or informal)
- inventories, investigations
- learning logs or journals
- media products
- observations (structured or informal)
- peer assessments
- performance tasks
- portfolios
- presentations
- projects
- questioning
- questionnaires, inventories, and surveys
- quizzes, tests, examinations
- rating scales
- reports
- reviews of performance
- self-assessments
- sorting scales (rubrics)
- surveys
- videotapes
- work samples
- written assignments

Portfolios

A feature of assessment and evaluation in Math for the Workplace 12 is the use of portfolios. A portfolio is a purposeful selection of a student's work that tells the story of the student's efforts, progress, and achievement.

Portfolios engage students in the assessment process and allow them to participate in the evaluation of their learning. Portfolios are most effective when they provide opportunities for students to reflect on and make decisions about their learning. The students and teacher should collaborate to make decisions about the contents of the portfolio and to develop the criteria for evaluating the portfolio. Portfolios should include

- the guidelines for selection
- the criteria for judging merit
- evidence of student reflection

Portfolio assessment is especially helpful for the student who needs significant support. Teachers should place notes and work samples from informal assessment in the portfolio and use the portfolio to collaborate with the student in identifying strengths and needs, selecting learning experiences, and selecting work that best reflects the student's progress toward learning outcomes.

It is important that students share their portfolios with other students so that all students may see exemplars that represent a range of strategies for expression and levels of complexity in ideas and understanding.

Outlines and other evidence of planning, along with multiple revisions, allow students to examine their progress and demonstrate it to teachers, parents, and others.

Students should be encouraged to develop a portfolio that demonstrates their achievements in a context beyond a particular course, including letters, certificates such as WHMIS and Workplace Safety, and photographs, for example, as well as written documents. A high school portfolio can be very helpful when students need to demonstrate their achievements to potential employers or when applying for admission to educational institutions. Students in Math for the Workplace 12 should consider adding work samples from each module with special consideration given to Modules 2 and 4. These modules give the student the opportunity to showcase his or her individual interest in a particular career.

Tests and Examinations

Traditional tests and examinations are not, by themselves, adequate to assess student learning. The format can be revised and adapted to reflect key aspects of the curriculum. Some teachers, for example, have designed tests and examinations based on collaborative or small-group, project, or portfolio learning. Creating opportunities for students to collaborate on a test or examination is an effective practice in the interactive classroom, when assessing learning of a higher order than recall of information, for example, learning that requires synthesis, analysis, or evaluation.

In learning activities that involve responding to a text or solving a problem, for example, students might work collaboratively to clarify and define the task and then work either collaboratively or individually to develop an answer. Students might be given a range of questions, issues, or problems and work collaboratively to clarify the assignment and plan a response in preparation for the examination when only one of the questions, issues, or problems is assigned. The initial list of questions, issues, or problems can be developed by the teacher, negotiated by the teacher with students, or developed by students and screened by the teacher.

Process-based tests and examinations allow students to demonstrate knowledge and skills and apply strategies at multiple stages in learning processes, for example, in creating texts, responding to texts or issues, solving problems, or gathering, evaluating, and synthesizing information.

Traditional tests and examinations may present a number of problems in scheduling and resource allocation. Process-based tests and examinations may be undertaken in steps during several class periods over a number of days. Students have opportunities to revise, reflect on, and extend their knowledge and understanding. Teachers have opportunities to develop comprehensive assessments, to monitor and evaluate learning at multiple points in a process, and to use time flexibly.

Preparation for Entrance and Certification Exams

In Math for the Workplace 12, students will need to prepare to demonstrate their learning through entrance tests and examinations or to obtain or upgrade a certification. Replicating this type of assessment in the classroom can help students prepare for the conditions and assessment formats they may encounter in workplace and post-secondary situations.

To make this kind of assessment an effective learning experience, teachers should define a specific context and purpose, for example, the operation of a device, the identification of materials labels, or the demonstration of a technique or procedure.

Students can take the opportunity when communicating with skilled tradespersons to ask the format of entrance and certification exams. Examples of this type of exam can be quite valuable for students preparing to enter a specific career.

Appendices

Appendix A: Resources

Teachers should note that this list of resources is current as of the publication of this guide and that some resources will change over time. Teachers should consult *Authorized Learning Resources*, which can be accessed through the Department of Education website. As new resources are approved for Math for the Workplace 12, they will be added to this list.

In addition to the resources listed in this appendix, Internet resources can also be valuable when planning learning, teaching, and assessment activities. Teachers are responsible for checking websites before students access them to ensure that they are appropriate for student use. Teachers should be fully advised of provincial, board, and school policies pertaining to Internet use. In particular, teachers should familiarize themselves with the *Internet Access and Use Policy for Nova Scotia Schools*, available through the Department of Education home page.

Many excellent materials exist in support of the Math for the Workplace 12 curriculum. Physical and human resources extend beyond the classroom and into the community, and it is important that teachers and students have access to a wide variety of them. The range of resources must

- affirm the diversity of learners' interests, needs, abilities, and experiences
- support the achievement of film and video curriculum outcomes
- include appropriate equipment and technology

Print Resources

Student and Teacher Resources

- Ball, John E. *Practical Problems in Mathematics for Masons.* Albany: Delmar Publishers Inc. 1980. ISBN 0-8273-1283-0.
- Belanger, C et. al., *Mathematics: Continuum.* Rogue Media Inc: Calgary, Alberta. 2002.
- Boatwright, Donna D. *Practical Problems in Mathematics for Industrial Technology.* Toronto: Thomson Delmar Learning. 1996. ISBN 0-8273-6974-3.
- Carman, Robert A., and Hal M. Saunders *Mathematics for the Trades: A Guided Approach (7th ed.).* Ohio: Prentice Hall, Pearson, 2005. ISBN 0-13-114525-8.
- Davis, Dennis D. *Practical Problems in Mathematics for Manufacturing (4th ed.).* Toronto: Thomson Delmar Learning. 1995. ISBN 0-8273-6710-4
- Dennis, Ervin A., Vermeersch, LaVonne, & Southwick, Charles. *Practical Problems in Mathematics for Graphic Communications (2nd ed.).* Toronto: Thomson Delmar Learning. 1998. ISBN 0-8273-7946-3.
- DeVore, Russell B. *Practical Problems in Mathematics for Heating and Cooling Technicians (4th ed.).* Toronto: Thomson Delmar Learning. 2005. ISBN 1-4018-4177-5.
- Erickson., S., Anderson, D., Hillen, J., and Wiebe, A. *Proportional Reasoning: Algebraic Thinking Series*, AIMS Publishing, California. 2003.
- Fisher, R. *Mastering Essential Math Skills.* 1998.
- Herman, Stephen L. *Practical Problems in Mathematics for Electronic Technicians (6th ed.).* Toronto: Thomson Delmar Learning. 2004. ISBN 1-4018-2500-1.
- Herman, Stephen L. *Practical Problems in Mathematics for Electricians (7th ed.).* Toronto: Thomson Delmar Learning. 2005. ISBN 1-4018-9085-7.
- Hope, J., Reys, B., & Reys, R. *Mental Math in Junior High.* Dale Seymour Publications: Paloalto, CA. 1988.
- Huth, Harry C., and Huth, Mark W. *Practical Problems in Mathematics for Carpenters (8th ed.).* Toronto: Thomson Delmar Learning. 2006. ISBN 0-4018-7215-8.
- Larkin, John C. *Practical Problems in Mathematics for Drafting and CAD (3rd ed.).* Toronto: Thomson Delmar Learning, 2005. ISBN 1-4018-4344-1.

- Moore, George., Sformo, Todd., & Sformo, Larry. *Practical Problems in Mathematics for Automotive Technicians (6th ed.).* Toronto: Thomson Delmar Learning. 2005. ISBN 1-4018-3999-1.
- Schell, Frank R., and Matlock, Bill J. *Practical Problems in Mathematics for Welders (4th ed.).* Toronto: Thomson Delmar Learning. 1996. ISBN 0-8273-6706-6.
- Simmers, Louise. *Practical Problems in Mathematics for Health Occupations (2nd ed.).* Toronto: Thomson Delmar Learning. 2005. ISBN 0-4018-4001-9
- Sturtevant, Thomas B. *Practical Problems in Mathematics for Emergency Services.* Toronto: Thomson Delmar Learning. 2000. ISBN 0-7668-0420-8.

Appendix B: Interview Questions

When students interview a skilled tradesperson as part of Module 2, they will brainstorm a number of questions they would like to ask a person in the career of their interest. Find below some suggestions to keep the focus on mathematics. Although this course does not have the seven strands of other core mathematics courses, the questions are labelled according to strand in a typical core mathematics course.

Number Sense Questions

A1. What types of numbers (fractions, decimals, ratios) do I need to know?

A2. Do I need a calculator?

A3. When do you estimate as opposed to calculate?

A4. What technology (programs, software) do you use?

A5. What measurement tools do you use?

A6. What scales of measurement do you use?

A7. What units do you use? What is the most common?

Operation Sense Questions

B1. What are the most common calculations?

B2. Are there any formulas that I need to know?

B3. Are significant digits used?

B4. How much precision and accuracy are required?

Patterns and Relations Questions

C1. Do you use any templates or jigs in your trade?

C2. Are there any patterns that are commonly used?

C3. Is any type of design technology used?

C4. Is there any orientation or sequence of materials before assembly?

Measurement Questions

D1. What units do you use on a regular basis?

D2. What are some common conversions?

D3. Is estimation used in your measurements and when?

D4. Do you carry any tables?

D5. Are blueprints important?

D6. Are you using two dimensions or three dimensions in your blueprints?

Geometry Questions

E1. Do you sketch your work before you build?

E2. What shapes/containers are important to know?

E3. Do I have to know relationships between shapes?

E4. Are calculations required based on these shapes?

E5. What are some common angles that are important to know?

E6. In what situations is trigonometry used?

Statistics Questions

F1. Are there data displays that you need to be familiar with?

F2. When dealing with graphs and charts, are you the person that makes the display or is it sufficient to be able to read the display?

Probability Questions

G1. Are you aware of any aspect of your career that makes use of chance?

Appendix C: Sample Course Outline

This section gives a sample course outline for students and their parents. Teachers are encouraged to develop their own course outline but can use parts of the outline below if they find it helpful. The evaluation and assessment section is meant to be adjusted to fit with the program as offered in your school and board.

Math for the Workplace 12

Teacher: _____ E-mail: _____ Date: _____

Content and Time Outline

Over the last several years, instructors at the Nova Scotia Community College (NSCC) have identified some areas that need improvement in terms of the mathematical knowledge base of students entering various trades. This course will work toward improving the students' mathematical knowledge base, and most aspects of the course will be directly related to trades such as carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry. This course will be modular based and project oriented to reflect the type of learning that will occur when students move on to NSCC. The following content and time outline is approximate:

Module 1: Measurement

January 31–February 28

Module 2: Mini-project: Mathematics and Career Exploration

March 1–March 25

Module 3: Ratio, Rate, and Proportion

March 28–April 29

Module 4: Major Project: Math Preparation for the Workplace

May 2–June 3

Course Structure

This course will include many different instructional and learning strategies, such as:

- project based learning
- teacher directed instruction
- class discussion and investigation
- cooperative learning (group work)
- student presentations
- mental math strategies
- use of manipulatives (such as pattern blocks and measuring tapes)
- use of technology (graphing calculators, computers, etc.)

Materials

Nova Scotia Community College (NSCC) 2004–2005 calendar, calculator (a simple scientific calculator is fine), notepaper, graph paper, binder, pencil, eraser, ruler, measuring tape for home, and a protractor

Evaluation and Assessment

This is an essential component of teaching and learning in mathematics as well as all trades. It helps to identify whether teaching has been effective, whether students have learned, and how best to address future student learning needs. The following is an overview of how students will be evaluated. This course will be marked as a regular semestered course with

35 percent of the final mark coming from the April report card, 35 percent of the final mark coming from the June marking period, and 30 percent of the final mark coming from the final examination. The mark for the April and June reporting periods will be made up from the following:

- Notebook and logbook ..... 10 points
- Mental math ..... 10 points
- Projects ..... 30 points
- Presentations ..... 10 points
- Homework ..... 15 points
- Class/group participation ..... 5 points
- Tests/module evaluations ..... 20 points

Other

1 Students will be expected to keep organized, neat notebooks and must come to class prepared at all times. All students must keep their notebooks up to date; will be evaluated periodically. A logbook is a small pocket-sized notebook that will be required when doing projects such as calculating the length of your pace, measuring and cutting materials, and many other times during project work. Once student's logbook is full, it is passed in to the teacher for evaluation. In a logbook, neatness is not as important as having a place to record dimensions of materials and for doing small calculations. An example of a logbook will be shown at the start of the course.

2 Homework mark when checked will be marked as follows:

0 points–no outcomes complete	3 points–shows understanding of problems
1 point–just final answers	4 points–most outcomes correct
2 points–attempted but incomplete	5 points–all outcomes complete, correct

3 A student who misses a class is responsible for finding out what work was missed during their absence. If homework was checked and a mark given, the student will receive a zero for that homework assignment unless the student shows the teacher their work the next day they are in school.

4 A student who misses a test will receive a zero for that test unless prior notice has been phoned into the office by a parent/guardian, or a note is received the next day the student is present in school, or if special circumstances did not allow the student to attend school. If notification has been given, the student must be ready to write the test on the first day back at school. The same policy stands for any projects, assignments, presentations, etc.

5 Mental calculations have been identified as important to be able to being a successful tradesperson. Specifically, basic operations of addition, subtraction, multiplication, and division both mentally and without a calculator will be part of this course.

Note to parents

As you can see, your son or daughter will be quite busy with this course. From my experience, it is necessary for students to attempt the homework problems for them to be successful in this course. In this course, the project work will also be vital to their understanding of the mathematics that pertains to many trades. If they do not understand a certain problem, please encourage them to visit me in Room _____ the next morning before school so that the problem can be fixed before the next math class.

If you have any questions or concerns about your son or daughter's progress, please do not hesitate to give me a call at _____ any morning before school or e-mail me at the address at the top of this page.

Sincerely,

_____

Math for the Workplace 12 teacher

School: _____

Appendix D: Sample Lesson Plans

Find below lesson plans for the entire course. Teachers are encouraged to adust the lesson plans to best suit the needs of the students taking the course in their schools.

Module 1: Measurement (20–30 hours)

Module Summary

In this module, students will have the opportunity to learn about measurement topics that involve imperial units in addition to conversions between metric and imperial units. The use of a measuring tape will be introduced as a way to identify many of the fractions that are utilized in various trades. Students will learn a method to aid in any conversion, whether metric or imperial, that will not require memorization of a large number of conversion factors.

Lesson Plan 1 (3-4 hours)

Topic

Accuracy and Precision

Outcomes

- demonstrate an understanding of the meaning and uses of accuracy and precision

Lesson Summary

In this lesson, students will learn the difference between accuracy and precision and will use measuring tapes, metre sticks, Vernier calipers, and 30 cm rulers to record various measurements.

Materials

- Measuring tapes
- metre sticks
- Vernier calipers
- 30-cm rulers

Warm-up

Have students orally give the place value of the following numbers: 27.3, 100.625, 0.02, etc. Then choose a staff member and have students guess their age. A short discussion could take place on how there can be only one correct answer for the staff member's age. An example to find the calibration of a measuring device would be to count the spaces between zero and one. If there are eight spaces, then each mark denotes one-eighth.

|||||||||

Development

Through a class discussion, try to come up with the meanings of accuracy and precision and how they are different. (See Miles, john H., *Basic Technical Mathematics*, p. 34.) Have students record the definitions in their notebooks along with several examples. Have students take measurements on several items available in your classroom using all of the following measuring instruments: tape measure in inches, metre stick in cm, 30-cm ruler in cm. The following items could be measured, and the measurements compared and discussed in terms of accuracy and precision: teacher desk length, teacher desk width, white board length and width, window width, bulletin board length and width, textbook length, width, and height. Estimates on each item should be recorded by the students before any student gets out of their seat to do measurements.

Assessment/Reinforcement of Main Concepts

Complete pp. 36–37 in *Basic Technical Mathematics: A Sourcebook for Applications* (Miles 1989)

Extensions

For another explanation with further examples and practice, see pp. 269–291 in *Mathematics for the Trades: A Guided Approach.* (Carman and Saunders 2005)

Follow-up

As with many topics in this course, once a concept is developed, it should be used whenever appropriate in daily coursework to reinforce the underlying idea. This topic should be utilized throughout the remainder of the course when a measurement is taken. For example, when a measurement is taken, the teacher could ask whether accuracy or precision is important in the specific situation.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 2 (2 hours)

Topic

Fractions Found on a Measuring Tape

Outcomes

- use a measuring tape to measure tactile items in both imperial and SI units

Lesson Summary

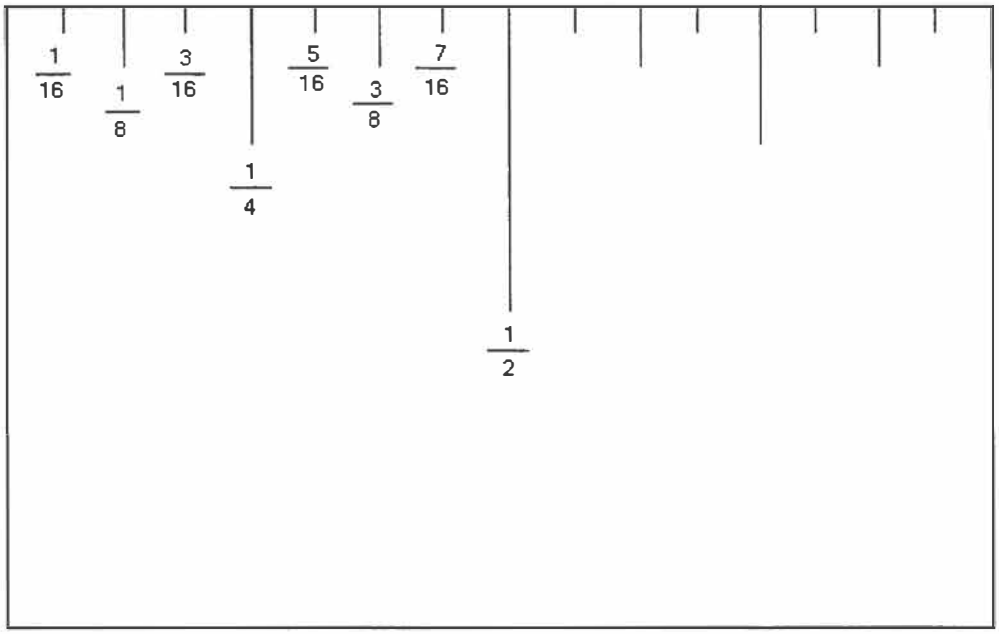
In this lesson, students will examine a measuring tape to discover the fractions that are used when taking basic measurements.

Materials

- Measuring tapes

Warm Up

Have students take measurements of specific items like the length of trim along one wall of the classroom and the height of a student's desk. Tell them to take note of how often an object has measurements that are whole numbers and how often fractions are involved in the measurement. Since most measurements are not exact whole numbers, it is important to have a solid knowledge of the fractions that are commonly used in the trades. Paper folding exercise: Students are to take a plain, white, 8 ½ x 11 sheet of paper and fold it along the longest side, then open the sheet and place a dot on the fold that is half the distance from the top to the bottom of the page. Draw a line from the dot to the top of the page. Repeat the folding along the same side and the drawing of dots and lines such that when you open the sheet of paper, you have created sixteenths. Each line should be labelled with the appropriate fraction. The final result should look like the figure below. The fractions for only the first half are shown.



Development

Have students examine a standard measuring tape to identify each marking. Start by going between any two whole numbers to identify the fraction ½. For example, students could be working between 5" and 6". The first mark for them to identify in this case would be 5 ½". A large sketch of a measuring tape could be placed on the board so that the fractions identified can be observed by all students. After the ½" measurement has been identified, find half of it. In our example, we are looking for the mark between 5" and 5 ½", namely 5 ¼". Use this knowledge to find 5 ½" then 5 ¾"". Continue this process to identify all marks on a measuring tape.

Assessment/Reinforcement of Main Concepts

The best reinforcement of this topic is to have students identify 20 different objects within the classroom. Have one student measure the first object and write their measurement on the board. The rest of the students in the class could extend their measuring tapes to the amount shown on the board. The teacher could generally assess whether or not most students are coming up with the same measurement. For the other items, each student should use their own measuring tape to measure the object. Each student should record their own measurements for all 20 objects. Once all students are finished their measurements, correct the measurements and highlight how often fractions are involved in constructing and measuring everyday tangible objects.

Extensions

Discussion could take place on the meaning of terms such as 5 7/8" strong or 3 ¼" shy.

Follow-up

Many measurements should be taken throughout the course thus providing practice using the fraction terminology and development measurement skills. Complete pp. 114-119 of *Basic Technical Mathematics: A Sourcebook of Applications* (Miles 1989).

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 3 (1 hour)

Topic

Identifying Length, Area, and Volume

Outcomes

- identify the difference between length, area, and volume

Lesson Summary

In this lesson, students will identify the difference between length, area, and volume in terms of the situations that require each measure and the units that are associated with each measurement.

Materials

- Measuring tapes
- metre sticks
- Vernier calipers
- 30-cm rulers.

Warm-up

Discuss some benchmarks for length, such as 10 cm being the approximate width of the back of your hand and 1 cm as being the approximate width of an index finger nail. It is also important to establish some benchmarks that are related to the imperial system of units. For example, benchmarks could be established for an inch, a foot, a yard, and a mile.

Development

Have students estimate various measurements such as the height of the classroom door, the area of the whiteboard, and the volume of the classroom. Discuss the units that are associated with each measurement. Ask students whether it makes sense to compare the height of the door with its area. Then have students come up with several situations that require length units such as baseboard trim and length of a string. Repeat for area and volume by soliciting suggestions from class members and discussing the suggestions.

Assessment/Reinforcement of Main Concepts

Use the Practical Problems in Mathematics series to have students work in groups to solve several problems, some of which involve length, area, and volume.

Extensions

Ask students whether all measurements will be a length, area, or volume. Read and analyse pp. 236–244 in *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005). Another extension could be to have students do their calculations for area and volume using length measurements in feet and yards.

Follow-up

Inevitably during the course, students will make the mistake of using an area unit when they intended a length unit and vice versa. Use other students in the class to check whether or not they think the unit was stated correctly. Short discussions and reminders may be necessary occasionally.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 4 (3 hours)

Topic

Significant Figures

Outcomes

- demonstrate an understanding of the meaning and uses of significant figures

Lesson Summary

In this lesson, students will learn how to identify and complete operations using significant figures.

Materials

Mathematics for the Trades: A Guided Approach (Carman and Saunders 2005)

Warm Up

Have students mentally calculate the number of digits in a number that is given to them orally. For example, the teacher could say "ten dollars and thirty five cents." Students should be able to state that there would be four digits in this example. Since the lesson will involve knowledge of the number, location with respect to the decimal, and type of digit, this exercise may be a useful warm up.

Development

See p. 222 in *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005). The section on significant digits has the basic rules listed. After each rule is explained, an example as well as a counter-example of that rule should be discussed so that students may make connections to their knowledge as they work through this topic. If all rules are stated at once, students tend to confuse one for another. Memorization of the rules is not as important as for the students to have a good working knowledge of them. Students may choose to write the rules with examples in their notes or on a cue card until they feel they can complete any calculation without the use of their notes.

Assessment/Reinforcement of Main Concepts

Use parts of pp. 222-235 in *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005).

Extensions

Have students complete a chart listing each rule along with a couple of examples.

Follow-up

As other calculations are completed during the remainder of the course, students should have the opportunity to apply the rules that they have learned during this lesson.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on Mastering Essential Math Skills by R. Fisher (1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 5 (5 hours – not all in one week)

Topic

Dimensional Analysis

Outcomes

- demonstrate an understanding of, and be able to solve problems using dimensional analysis
- identify, use, and convert among and between SI units and Imperial units to measure and solve measurement problems

Lesson Summary

In this lesson, students will learn how to convert from metric to Imperial units as well as convert from one unit to another using the method of dimensional analysis.

Materials

- conversion tables (one copy for each student)
- calculators

Warm-up

Lesson 19 in *Mental Math in Junior High*. (Hope, Reys, and Reys 1988) on p. 82.

Development

Students should brainstorm some metric conversions that they already know. Examples that may arise are 1000 m = 1 km or 60 s = 1 min, etc. Using the conversions that students have given, show the dimensional analysis method. For example, if the class knows the conversions above, they can convert any number of metres to kilometres and vice versa. In the same way, they can convert any number of seconds to minutes or vice versa. Students must be encouraged to carry the units through the calculation. Once they feel confident doing conversions between common numbers, then other conversion factors may be introduced, with the method staying the same.

Example:

1465 m = ? km

Method: Start with the given number and unit, in this case 1465 m. Then choose the conversion factor that has the unit you already have as well as the one you want. In this case the conversion factor *60 s = 1 min* has neither the unit we have or the one we want so it is information that will not be used. However, the conversion factor *1000 m = 1 km* has exactly what we need and what we are starting with, so it will be useful. The conversion factors can be written with either number on top of the fraction in the calculation. We must put the one on the bottom that will cancel what we are starting with.

$$1465 \text{ m} \frac{1km}{1000m} = 1.465 \text{ km}$$

Other examples of conversion factors could be referenced. It is important to have many conversion factors available when learning the process of dimensional analysis. When students need a conversion factor that they do not know, they will be forced to choose one from a reference text and it will normally contain many conversions, not just the one the student requires. Therefore, being able to identify the conversion factor they need from a large list is a critical skill to be developed.

Assessment/Reinforcement of Main Concepts

Power builder B on p. 82 in *Mental Math in Junior High* (Hope, Reys and Reys 1988) could be used as a quiz. Selected questions can be taken from pp. 236–268 in *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005). If the teacher thinks the class has a solid understanding of the concept presented, pp. 265–268 has ample practice.

Extensions

Use p. 177 of *Proportional Reasoning: Algebraic Thinking Series* (Erikson, Hillan, and Wiebe 2003).

Follow-up

Additional practice should occur throughout the course as one unit needs to be converted to another. If the method discussed in this lesson is developed and utilized each time a conversion is required, then the power of this method should become apparent to students resulting in high student proficiency by the end of the course. See pp. 38-41 of *Basic Technical Mathematics: A sourcebook for applications* (Miles 1989).

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher, 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 6 (3 hours)

Topic

Calculating the Distance of Your Walking Pace

Outcomes

- estimate distances by using a personal benchmark such as walking pace
- identify, use, and convert among and between SI units and imperial units to measure and solve measurement problems

Lesson Summary

In this lesson, students will be calculating the distance of their walking pace to be able to approximate distances when measurement is not required to be exact.

Materials

- 100 m measuring tapes or a metric distance measurement device
- 100 ft measuring tape

Warm-up

Lesson 1 in *Mental Math in Junior High* (Hope, Reys and Reys 1988).

Development

Using a designated area of the school's property, such as part of a soccer field, find a length of land that is a bit longer than 100 metres for use in calculating a person's pace length. It is best to use land that is not perfectly flat, so part of the soccer field could be used, along with the ditch and field beside if possible. Use the metric measuring tapes to stake off exactly 100 metres. Have each student walk between the stakes and record the number of steps it takes for them to walk 100 metres. Repeat three times so that once the students return to class, they will be able to calculate their own average pace using the three measurements and compare it to others in the class. On another day, students should go to the soccer or softball field to calculate the length of each field using only their pace as a measurement.

Assessment/Reinforcement of Main Concepts

Upon return to the classroom, students could calculate how many steps it takes them to walk a kilometre or one mile. As an assignment, have students count the number of steps it takes them to walk up their driveways or other distances that may be of interest to them for comparison in a subsequent class.

Extensions

Students could calculate the area of a soccer field using their pace so that they could suggest the number of bags of fertilizer that would be needed to treat a field of that size. If enough area is available in the vicinity of the school, students could stake off what an acre or hectare looks like to establish a benchmark in land area measurements. Students could graph estimates of how many paces they expect to take to walk 100 feet then graph the actual results and look for trends in the data.

Follow-up

Occasionally, students should be asked to use the knowledge of their pace to calculate distances both indoors and out. Have students estimate how far a particular walking trail would be, then walk the trail and compare student responses. Students could use their pace distance to approximate the length and width of a basketball and volleyball court.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 7 (3 Hours)

Topic

Pythagorean Theorem in Construction

Outcomes

- demonstrate an understanding of, and be able to solve problems using the Pythagorean Theorem

Lesson Overview

The purpose of this lesson is to teach students about the Pythagorean theorem, how to use it, and its application in real life situations. Using construction as the focus for the main problem, the teacher will introduce the lesson, working through the contextual math example, show the same math used in traditional examples, have the students demonstrate their understanding, and finish with a formal assessment of student learning.

Materials

- white board or overhead

Warm-up

Tell students that the day's lesson will be about triangles, and ask students to define "triangle." Discuss the need to work with triangles in the construction process. Ask students for examples of when triangles are used or apparent in construction and in everyday life. Sometimes we need to determine the area of the triangle, and sometimes we need to know the length of the sides. We may not have all of the information, so we need to calculate what we don't have.

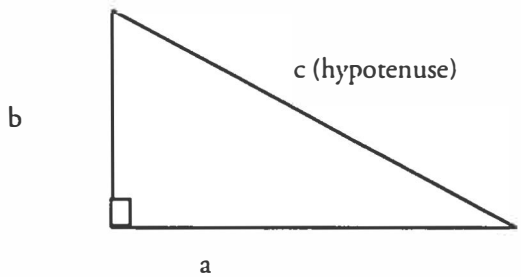
Development

Part 1

Students will have had basic arithmetic functions, including taking the square root of a number. Ask students about the different types of triangles, and be sure to identify the right triangle. Ask students why it is called a right triangle, and identify its characteristics. Draw pictures on the whiteboard during discussion. Explore students' ability to find the third side of a triangle if you know only the measurement of two sides. Introduce the $a^2+b^2=c^2$ formula, and use the 3-4-5 example ($3^2+4^2=5^2$). Explain that it is called the Pythagorean theorem. The Pythagorean theorem is a rule or formula that allows us to calculate the length of one side of a right triangle when we are given the lengths of the other two sides. Although the formula is named the ancient Greek mathematician Pythagoras, it was known to Babylonian engineers and surveyors more than 1000 years before Pythagoras lived. The Pythagorean theorem is as follows.

Part 2

For any right triangle, the square of the hypotenuse is equal to the sum of the square of the other two sides.



Equivalent forms of the Pythagorean theorem are:

$$c=\sqrt{a^2+b^2} \qquad a=\sqrt{c^2-b^2} \qquad b=\sqrt{c^2-a^2}$$

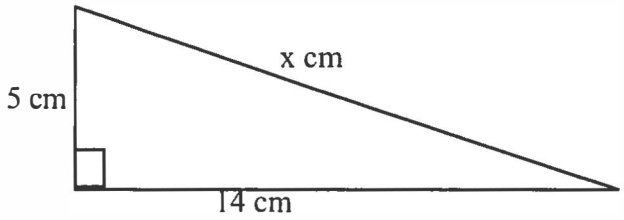
Part 3: Work through Traditional Math Example

Example

A right triangle has one side with a measure of 5 cm and another 14 cm. Find the length of the hypotenuse.

Solution

Step 1: Draw a picture. Fill in what you know.



Step 2: Use the correct form of the Pythagorean theorem to find the unknown side.

Since we are looking for the hypotenuse (c), we would use . $c = \sqrt{a^2 + b^2}$

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{5^2 + 14^2}$$

$$c = \sqrt{25 + 196}$$

$$c = \sqrt{221}$$

$$c = 14.87cm$$

Therefore, the unknown side length is 14.9 cm.

Sample Problems for You to Try

1. A right triangle has a hypotenuse of 50 cm and a side of 48 cm. Find the length of the other side of the triangle. (Answer: 14 cm)
2. A right triangle has a side that equals 9 cm and a side that equals 8 cm. Find the hypotenuse. (Answer: 12 cm)

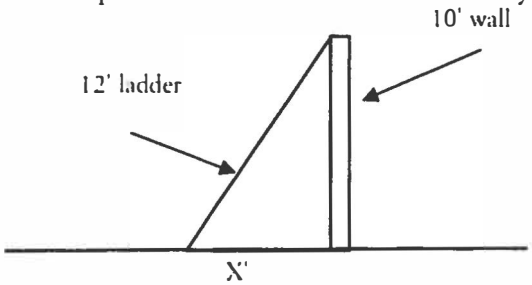
Part 4 Work through an Embedded Example

Example

A carpenter wants to use a 12-ft. ladder to reach the top of a 10-ft wall. How far must the base of the ladder be from the base of the wall?

Solution:

Step 1: Draw the picture on the whiteboard and identify what you know and what you need to find out:

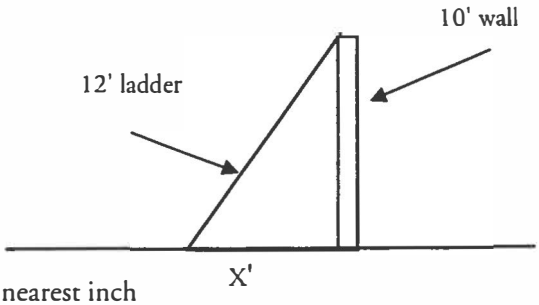


Solution: Use the formula to get $a = \sqrt{c^2 - b^2}$

X = $\sqrt{12^2 - 10^2}$

X = $\sqrt{144 - 100}$

X = $\sqrt{44}$



X ≈ 6.63 ft or 6ft 8 in, rounded to the nearest inch

Part 5 Work through Related, Contextual Examples:

1. A rectangular table measures 4 ft. by 6 ft. Find the length of a diagonal brace placed beneath the table. (Answer: 7.2 ft, or 7 ft 2 ½ in.)
2. Find the diagonal length of the stairway that has a 9 ft 9in base and is 8 ft 6 in high. (Answer: 12.9 ft or 12 ft 11 in rounded to the nearest inch)
3. What is the distance between the center of two pulleys if one is placed 9 in. to the left and 6 in. above the other? (Answer: 10.8 in.)

Assessment/Reinforcement of Main Concepts

The students will complete a worksheet with three to five problems and then partner up with another student to compare and check answers. Students will complete an assortment of math problems involving the application of the Pythagorean theorem to real-life problems.

Extension

Carpenter's Square

Module 2: Mini-project (15–20 hours)

Module Summary

In this module, students will have the opportunity to examine many skilled trades and to choose the top three that have caught their interest. Students will then work in groups to brainstorm interview questions for an individual currently works in the trade of their interest. Students will visit and interview a skilled tradesperson to seek answers to questions they have about the daily routine of the trade, working conditions, and mathematical requirements to be successful in the courses that are required to obtain the trade. By the end of Module 2, students should have the information and experiences to consider one specific trade they would like to focus on for the major project.

Lesson Plan 1 (3 hours)

Topic

Choosing three possible skilled trades to explore in greater detail

Outcomes

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades

Lesson Summary

In this lesson, students will be expected to read and find information using the Internet to explore in greater detail a skilled trade that could be one of the following: carpentry, welding, forestry, electrical, plumbing, power engineering, pipe fitting, steam fitting, interior decorating, metal working, machine technology, marine technology, auto mechanics, electronic technology, refrigeration, and masonry.

Materials

- NSCC calendar
- several computers with internet access

Warm-up

Have students share with the class the knowledge they currently have about what each tradesperson does in their daily work. The teacher could share with the class information about some of the trades personnel they know and how different people in the same trade can be working in quite different conditions.

Development

The teacher should obtain copies of the NSCC's calendar (from the school's guidance counsellor), which will contain course descriptions for students to read and discuss. Furthermore, the Internet could be utilized for finding information, in addition to the NSCC website (www.nscc.ca). Once students have identified areas of interest, then they should choose three skilled trades they will be exploring in greater detail. Students should visit a website or read a campus handbook to obtain information on where they can take each program they have chosen, when it begins, what type of courses they will be taking, what is required from high school for them to be able to take the program, how much it will cost, and any other questions they may have in regards to the three specific programs they have chosen.

Assessment/Reinforcement of Main Concepts

Have students hand in a report on the preliminary information they have found on the three trades they have selected to explore in detail. See Module 2: Mini-project Worksheet #1 (p. 85).

Extensions

Have each student talk to a friend or relative that has taken a trade but has much different duties than they would have expected upon entering the skilled trade.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* by (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Module 2: Mini Project Worksheet #1

Name: _____

Date: _____

Names of the three trades:

1. _____
2. _____
3. _____

Cost of each program:

1. _____ 2. _____ 3. _____

Short description of each program:

1.

2.

3.

What is the location of each of these programs?

1. _____ 2. _____ 3. _____

What part of each program is interesting to you?

1.

2.

3.

Lesson Plan 2 (1 hour)

Topic

Preparation of Interview Questions

Outcomes

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades

Lesson Summary

In this lesson, students will be preparing questions that they may ask a skilled trades person in an interview situation.

Materials

- NSCC calendar
- several computers with Internet access

Warm-up

Lesson 10 in *Mental Math in Junior High* (Hope, Reys, and Reys 1988).

Development

Students should work in groups of three to develop 10 questions that will be asked to a skilled tradesperson in a subsequent interview. Several questions should be directed toward gaining an understanding of what type of mathematics will be required to complete the courses associated with the trade. Furthermore, there should be questions that will determine what type of mathematics is involved in doing the daily work of the trade. For example, carpenters use fractions of an inch almost every time they take a measurement. The student should be gathering this type of information so as to motivate class learning of basic mathematics as it relates to the trades for which they have an interest. One of the questions should request from the skilled tradesperson a small project that the student could complete as a small example of some things that could be done in that specific career. For example, an example of a small carpentry project could be to build a birdhouse. See Appendix B for sample interview questions.

Assessment/Reinforcement of Main Concepts

Students could be marked on the quality of questions produced for their interview. Good quality questions should be shared with the class so that all students will benefit from the information they will gain when it comes to the interview.

Extensions

An extension of this assignment is to interview several individuals so as to gain a greater perspective for how some people enjoy different aspects of the trade than others.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* by (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 3 (1 hour)

Topic

Etiquette of an Interview

Outcomes

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades
- demonstrate to others what type of mathematical knowledge is required to be successful at various career choices

Lesson Summary

In this lesson, students will be preparing for their interview so they know what to expect when they conduct their interview with a skilled tradesperson.

Warm-up

Students could practise their interview questions with other students in the class. This will ensure that students would have a clear understanding of what they are asking.

Development

Students should work in groups of two to brainstorm on how they expect an interview to take place. Each student should take a turn being the interviewer and the interviewee. Discussion should take place as to how to co-ordinate the when, where, why, and who of the interview. When will you (the skilled tradesperson) be able to meet with me? Where will we meet? At what time? Why are we meeting? Who wants to meet? Answers to these questions should be clear in the student's mind before contacting the person they would like to interview for the first time.

Assessment/Reinforcement of Main Concepts

Students in groups of two could show the entire class what they expect to take place in their interview. At the end of their presentation, the rest of the class could critique what they have seen and what could be improved so that the interview runs smoothly and the student leaves with the information they intended to obtain.

Extensions

Students could practise their interview with a friend, parent, or relative to gain confidence in the type of situations that may arise.

Follow-up

At the end of this class, students should be ready to contact the person they would like to interview.

Note: If interviews are not all set up at this point, students could start Module 3 then come back to finish this module once all students have interviewed a skilled tradesperson.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 4 (2 hours)

Topic

Analysis of the Interview

Outcomes

- investigate a range of career opportunities to determine the best personal fit for their interests within the trades
- demonstrate to others what type of mathematical knowledge is required to be successful at various career choices
- demonstrate entry level competence in the mathematics associated with the specific career choice the student has made

Lesson Summary

In this lesson, students will be presenting information to the rest of the class that they have obtained in their interview so that all students find out as much information as possible about skilled trades.

Warm-up

Have an informal discussion about some of the mathematics the students did not realize were essential to performing a specific trade. Use this knowledge to choose a lesson from *Mental Math in Junior High*. (Hope, Reys, and Reys 1988).

Development

Students should prepare to present their findings to the rest of the class. Of special interest is the mathematics required for each of the trades that were examined. This information will subsequently be used to guide the teacher's examples of more theoretical material.

Assessment/Reinforcement of Main Concepts

Each student could present their findings to the entire class. Teachers could develop a rubric with the aid of the class as to the types of information they are looking for in a good presentation.

Extensions

Students could make posters to promote the trade in which they are most interested. If several students choose the same trade, they could work in pairs or small groups.

Follow-up

At the end of this class, students should be ready to think about which one of the three trades they will choose for the major project later in the course.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 5 (5 hours)

Topic

Construction of the mini-project model.

Outcomes

- sketch and construct a model that will enable a student to show others some mathematics involved in a career interest

Lesson Summary

In this lesson, students will be using an idea either they have developed or have obtained from the skilled tradesperson to draw on paper, then construct a model.

Materials

Materials for this lesson may need to be found around the school or at home, depending upon the particular student's mini-project.

Warm-up

Lesson 33 in *Mental Math in Junior High* (Hope, Reys, and Reys 1988).

Development

Students should prepare a blueprint on paper for a model they plan on sketching as well as constructing with available materials. For example, a student with an interest in carpentry may draw a sketch of a birdhouse on paper, including all measurements. The student could then use cardboard to construct the model.

Assessment/Reinforcement of Main Concepts

Students should be marked on the quality of their blueprints and models. NSCC instructors could be invited to visit the class once the models have been constructed so they could identify for students what types of things they will be looking for when they evaluate the major project later in the course. This type of activity would give students experience in having an NSCC instructor mark a tangible project, as well as being in contact with another person in the trades.

Extensions

Students could be required to choose a material, such as wood in the carpenter's project, so that costs associated with buying the material as well as completing the mini-project could be calculated. Each student could provide an inventory of both the materials and the tools required to build their model.

Follow-up

Once the mini-projects are marked, students could make notes on how to improve their project in preparation for the major project.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Module 3: Ratio, Rate, and Proportion (20–30 hours)

Module Summary

In this module, students will have the opportunity to examine a number of topics related to ratio, rate, and proportion as they apply to various trades.

Lesson Plan 1 (3 hours)

Topic

Blueprints

Outcomes

- calculate the dimensions of actual objects using blueprints with various scales

Lesson Summary

In this lesson, students will use blueprints to examine scale drawings and construct actual sized models.

Materials

- set of blueprints
- masking tape
- measuring tapes

Warm-up

Lesson 21 in *Mental Math in Junior High* (Hope, Reys and Reys 1988). Many schools have access to a copy of the blueprints for the school, and these provide a great display to show the variety of scales that are involved with blueprints.

Development

Using a blueprint provided by the teacher, students should work in small groups to calculate the dimensions of the actual object using the scale provided on the blueprint. If blueprints of objects such as a garbage box or doghouse can be obtained, then students could construct a model using masking tape and a corner of the classroom. Blueprints using multiple scales should be used. For example, a blueprint of one wing of a school could have a scale of 1/8" = 1' actual whereas a blueprint showing the top view of a school could have a scale of 1' = 40' actual.

Assessment/Reinforcement of Main Concepts

Students should complete pp. 91-94 of *Proportional Reasoning: Algebraic Thinking Series* (Erikson, Anderson, Hillen, and Wiebe 2003)

Extensions

Students could make a blueprint of a room in any house or building that they think is interesting. For example, it could be their friend's recreational room, their own kitchen, or a school lunchroom. The actual measurements need to be taken, so measuring tapes may need to be borrowed for this home assignment.

Follow-up

Display the blueprints that the students have drawn and, at a glance of the scales, decide who chose the largest and who chose the smallest rooms.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* by (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 2 (2 hours)

Topic

Three dimensional drawings with paper to model size comparisons.

Outcomes

- sketch and build representations of three-dimensional objects using a variety of materials and information about the objects

Lesson Summary

In this lesson, students will use cube-a-links and isometric dot paper to make 3-D drawings of tangible objects. Students will then create a scale to compare their objects.

Materials

- connecting cubes such as Cube-a-links
- isometric dot paper

Warm-up

Lesson 40 in *Mental Math in Junior High* (Hope, Reys, and Reys 1988). Examples of three dimensional drawing will have to be shown to the class. Some examples would be how to draw a cube or a rectangular prism so that it looks three dimensional.

Development

Start with one cube from a set of cube-a-links and have students draw it on isometric dot paper. Students should shade the top of their drawing. Add one cube at a time to the original cube, having students make a new sketch each time until the model has five connected cubes in a pattern that is not a straight line. Try making four more configurations of five cubes, having students make a new sketch each time. If students are in pairs, they could show their sketch to a partner and see if the partner could construct a model using only the isometric drawing provided.

Assessment/Reinforcement of Main Concepts

Students could be asked to use isometric dot paper to sketch the classroom along with a few key objects within the room.

Extensions

Complete pp. 208–209 of *Continuum.* (Belanger 2002).

Follow-up

Students' understanding of presenting three-dimensional objects on two-dimensional paper will surface frequently. Use this concept to stress the importance of the blueprint component of the major project in Module 4.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 3 (4 hours)

Topic

Percents, Ratios, and Decimals

Outcomes

- illustrate, explain, and express ratios, fractions, decimals, and percentages in alternative forms

Lesson Summary

In this lesson, students will review the relationship between a fraction, decimal, and percent using examples from the trades.

Materials

The following textbooks are recommended for this lesson:

- *Practical Problems in Mathematics for Automotive Technicians* (Moore, Sformo, and Sformo 1998)
- *Practical Problems in Mathematics for Carpenters* (Huth and Huth 2001)
- *Practical Problems in Mathematics for Electricians* (Herman 2002)
- *Practical Problems in Mathematics for Electronic Technicians* (Herman (2004)
- *Practical Problems in Mathematics for Graphic Communications* (Dennis, Vermeersche, and Southwick 1998)
- *Practical Problems in Mathematics for Heating and Cooling Technicians* (DeVore 1998)
- *Practical Problems in Mathematics for Manufacturing* (Davis 1996)
- *Practical Problems in Mathematics for Masons* (Ball 1980)
- *Practical Problems in Mathematics for Drafting and CAD* (Larkin 1995)
- *Practical Problems in Mathematics for Welders* (Schell and Marlock 1995)

Warm-up

Lesson 50 in *Mental Math in Junior High* (Hope, Reys, and Reys 1988). Students could write a definition for percent and decimal and give examples of each.

Development

Students will first convert a fraction into a decimal then attempt some trade specific problems on the topic. A brief review of the procedure to convert fractions into decimals should start the lesson. Each student can choose the appropriate pages from one of the reference books to complete a few problems on this topic (see materials list above).

Once students become familiar with these titles, they can be utilized for practice problems on many topics completed in this course. The next example would be for converting percentages into decimals and fractions. Again, students should use the above titles to practise the problems in a trade-specific area that is interesting to them.

Assessment/Reinforcement of Main Concepts

Complete portions of pp. 159–182 in *Mathematics for the Trades: A Guided Approach* (Carman and Saunders 2005).

Extensions

Topics will arise from Module 2 that should allow for further discussion on how certain aspects of mathematics are required for specific trades. This lesson should lend itself to this idea. For example, percentages, fractions, and decimals are used in calculations for product purchases in all trades.

Follow-up

In Module 4, students should be expected to use the most appropriate form of a fraction, decimal, or percentage when presenting information in blueprint form in regards to their major project.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 4 (1.5 hours)

Topic

Pulse Rates

Outcomes

- find and calculate rates in practical applications such as pulse rate

Lesson Summary

In this lesson, students will be calculating their pulse rate in beats per minute. This activity should allow for the use of many previous lessons such as the dimensional analysis lesson from Module 1: Measurement and the previous lessons in this module.

Materials

- Stop watches

Warm-up

Lesson 19 in *Mental Math in Junior High* (Hope, Reys, and Reys 1988). As part of the warm up have a discussion on blood pressure and how it is related to pulse rates. Highlight the causes and effects of high/low blood pressure.

Development

Students will need help in finding the areas of their neck or wrist where pulse rates are normally taken. Once all students have found their pulse, the teacher could have all students count the beats for 15 seconds. Repeat this procedure three times to find the average number of beats for each student in 15 seconds. Students could then use dimensional analysis to calculate their pulse rate per minute. Dimensional analysis is preferred over just multiplying by four so that students can understand the method. Dimensional analysis can also be used in this case to calculate the number of beats in a day, week, and year. In each of these cases, it is not so obvious what number to multiply to obtain a correct answer; however, the method of dimensional analysis will work each time.

Assessment/Reinforcement of Main Concepts

Complete pp. 255–260 of *Continuum* (Belanger 2002).

Extensions

Complete pp. 156–157 of *Proportional Reasoning: Algebraic Thinking Series* (Erickson, Anderson, Hillen, and Wiebe 2003).

Follow-up

Have students graph their number of heartbeats versus time in seconds, then minutes, to see if there are any trends within the class.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 5 (2-3 hours)

Topic

Gross Income, Net Income, and Income Tax

Outcomes

- estimate and calculate deductions taken from a pay stub as percentages of gross earnings

Lesson Summary

In this lesson, students will examine a pay stub from a student and compare it to a pay stub from a skilled tradeperson. Comparisons should be made on the proportion of the gross income that is paid to income tax by students and by adult workers.

Materials

- pay stub from a student with name removed
- pay stub from a skilledtrades person with the name removed.

Warm-up

Have students estimate the amount of income tax, CPP, and EI that would be deducted from an adult worker's pay cheque. Use their estimates to calculate the percentage of gross pay that they think is contributed to income tax, CPP, and EI.

Development

Show students the actual amount that a skilled worker pays into income tax, CPP, and EI on a weekly or bi-weekly basis. Use these actual amounts to calculate the percentage of gross income that is contributed to these funds. Compare the results of the estimates with the actual amounts. Briefly discuss the services that Canadians receive for paying into these funds. Use a formula for percent error to compare each individual's estimate with the actual.

Assessment/Reinforcement of Main Concepts

Complete pp. 20-21 in *Quantum* (Belanger 2003).

Extensions

Use the pay stub to calculate the annual gross income, annual net income, and the annual amounts that are contributed to income tax, CPP, and EI.

Follow-up

Have students talk to a self-employed individual to inquire as to how they account for payments of income tax as well as other deductions.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 6 (2-3 hours)

Topic

Combining measurement with ratio and proportion.

Outcomes

- sketch enlargements and reductions of objects using various scales

Lesson Summary

In this lesson, students will construct a drawing on the whiteboard using a smaller scale to show the enlargement effect.

Materials

- A picture or drawing that will fit onto an 8 ½" by 11" sheet of paper, one copy per student or one copy for the class.

Warm-up

Lesson 47 in *Mental Math in Junior High* (Hope, Reys, and Reys 1988)

Development

Divide the picture into several squares—as close to the number of students in the class as possible. Assign each student a square to enlarge to the size of a piece of paper 8 ½" by 8 ½". Once each student has completed their sketch, tape each student's work on the front board to display the enlarged picture. The teacher may want to cut the original picture into small squares before any student sees it to motivate students to discover what the actual final object may be.

Assessment/Reinforcement of Main Concepts

Complete pp. 99–103 of *Proportional Reasoning: Algebraic Thinking Series* (Erickson, Anderson, Hillen, and Wiebe 2003)

Follow-up

Students could calculate distances on a map from one city to another using the scale given on the map. Keep in mind that dimensional analysis should be utilized during this activity.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 7 (3 hours)

Topic

Using Trigonometry in Industry

Outcomes

- use the slope formula to solve trigonometric problems commonly found in industry

Lesson Summary

In this lesson, students will be introduced to slope = $\frac{rise}{run}$ formula used when solving trigonometric problems in industry. Students will use the Pythagorean theorem studied previously to help them further develop the concepts in this unit on triangle trigonometry.

Development

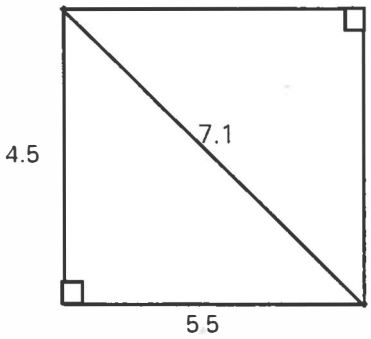
Triangle trigonometry is present everywhere and in almost every profession. Look up at the roof of your house; notice the triangular pitch at the tip of the roof. Open the cupboard under your sink, notice the shape of the piping—sometimes you may see an angular design. Next time you enter a public building, notice whether or not they have a ramp, then notice the shape of the ramp. Is there any trigonometry present? The police also must use trigonometry to solve crimes, such are case when they investigate shootings. So you can see, the need for an understanding of Pythagoras and the $\frac{rise}{run}$ ratio are necessary for all sorts of professions in our society.

In the construction industry, in particular, trigonometric ratios play a critical role in the design and building of stairs, calculating the rafter line length using the measurements of rise and run, and the construction of ramps, among other pieces. Teachers will start with a few contextual problems with the students and then have the students work through a few on their own. Following this, students will be asked to complete a project assignment where they will be asked to combine all of the concepts learned in the lesson in one final assessment.

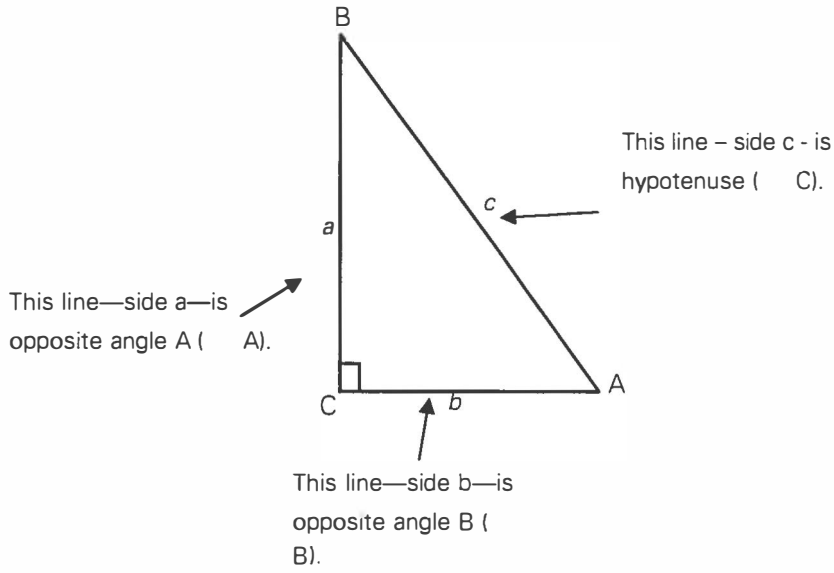
Part 1: Contextual Problems

Problem 1

Sarah is a building inspector in Ingonish River. She is in a house checking to see if the walls in a house are square and she tells her assistant, Paul, that it is easy to check using Pythagoras. Using the diagram below, show how Sarah might explain to Paul the way to check the wall is straight using the Pythagorean theorem.



Sarah explains to Paul a little about Pythagoras using the following diagram.



Sarah explains that *a* and *b* are sides (legs) to a right-angled triangle where c is called the hypotenuse and it is the longest side. Pythagoras said that $a^2 + b^2 = c^2$ for all right-angled triangles.

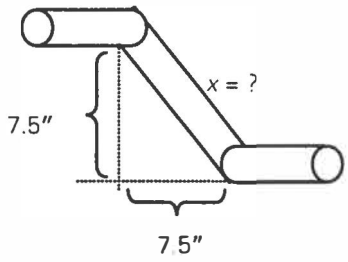
If the walls were square, Sarah explained, then 7.1 would equal $\sqrt{(4.5^2 \quad 5.5^2)}$. Does it?

Answer

Yes

Problem 2

Piping in a house must have the following dimensions. What should be the length of the pipe used?

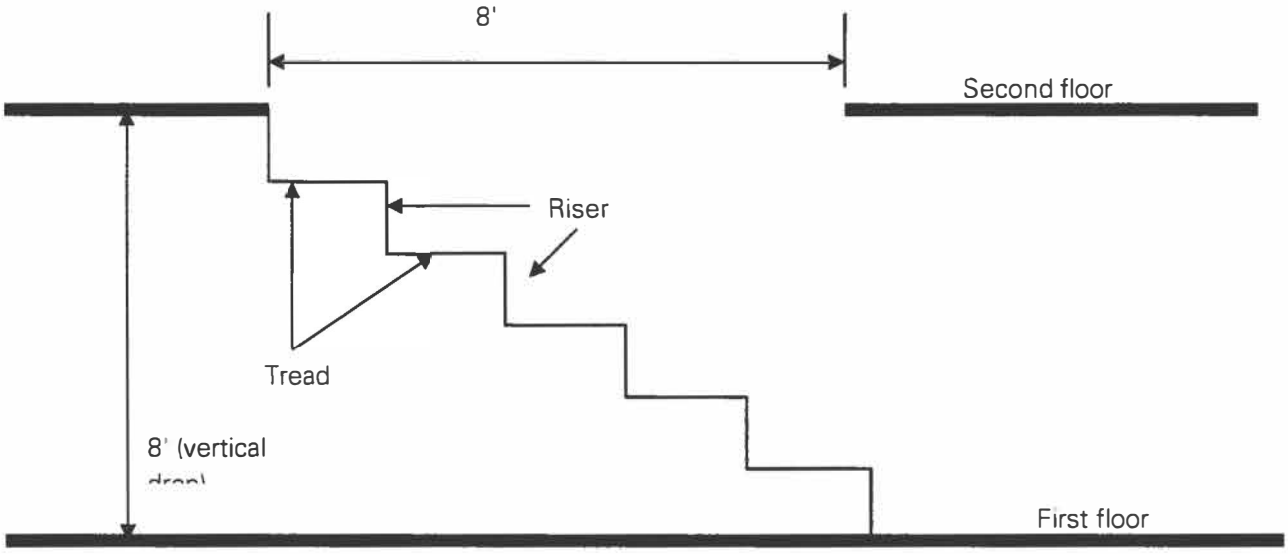


Answer:

10.6"

Problem 3

A stairway must be designed and built that leads from the first floor to the second floor. The opening in the floor for the stairway has been measured to be 8 feet long and 3 feet wide. The distance from the first floor to the second floor has been measured at 8 feet. Calculate the dimensions of the risers and treads and create a specification for the stair stringers that meets local building codes.



Using graph paper (using a scale of 1 square per 2 inches) make a diagram of your stairway stringer and indicate the dimensions as follows:

Total number of risers: _____ (a riser must be 7").

Total number of treads (step plate): _____ (the step plate must be 9")

Your stairway should form a triangle. Draw a line that just touches the tips of each stair and let it intersect with the first floor and the second floor lines. This is the hypotenuse of the triangle. The vertical drop is the y axis and the first floor is the x axis of the triangle. What is the slope formed by your stairway? The slope = $\frac{rise}{run}$

Slope = _____.

Answers:

Risers: 14 risers (14th will be only 5" high); either that or make the last step (13th) a taller step.

Treads (step plates): 11 stairs (11th step will be only 6" long); either that or make the last (10th) step a longer step

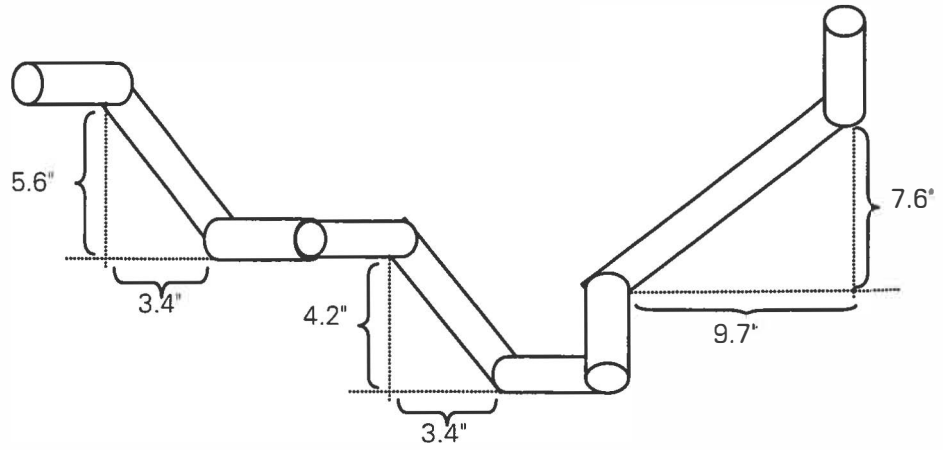
Slope = 8/8 = 1

Part 2: Questions for Students

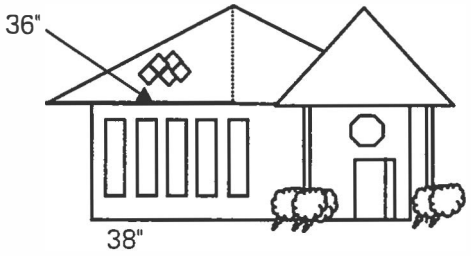
A ramp is to be built for a street that is 15 feet long. The standard slope for any ramp is 1/12, that is, it rises 1 unit for every 12 units it is long. How high is the top of the ramp above the ground? *Hint: Draw a diagram.*

You have built a set of stairs for a house using the standard specifications (7"risers and 9" step plates). In the house, you have 14 stairs. What is the height between the two floors? Draw a diagram of your staircase. What is the slope of your staircase?

You are asked to complete this diagram for your lead plumber. Fill in the missing numbers. If each of the smaller pipes measures 5", what is the total amount of pipe needed?



James is building a house for his friend Dave. His basic diagram is shown below. What is the length of the missing side? James builds two types of houses, bungalows and cape cods. A bungalow has a roof slope of 4/12 and a Cape Cod has a roof slope of 7/12. What type is he building for Dave?



Assessment/Reinforcement of Main Concepts

Project:

You are asked to construct a diagram of a Cape Cod that is to be 54' long. It will have at least 3 steps leading to the front entry and then at least 10 steps from the first to the second floors. The owner would also like a ramp installed along the front, approximately 10' long. Draw a diagram, using graph paper, and show all of your measurements.

Module 4: Major Project (15–20 hours)

Module Summary

At the start of this module, students should have identified one career that they will spend a considerable amount of time to research in much greater detail than they did in Module 2. If the career is different than any of the three that were chosen for the mini-project, then they should obtain the information from a class member who has explored the career they will now focus on. By the end of this module, students should have been exposed to a variety of information and experiences that will help them with the mathematics associated with their career choices. It is important to note that when assessing student projects, the mathematics must be explicitly stated throughout their project.

Lesson Plan 1 (5 hours—most of this is spent at NSCC, with only about 1 hour of actual class time debriefing)

Topic

NSCC Visitation – "Test Drive"

Outcomes

- demonstrate to others what type of mathematical knowledge is required to be successful at their career choice
- demonstrate competence in the mathematics associated with the specific career choice the student has made

Lesson Summary

In this lesson, students will have the opportunity to visit the nearest NSCC campus to spend a day in the courses that they have identified as interesting.

Development

Early, in the term, the teacher or guidance department could set up one day in April or May for students in this course to visit the NSCC. Students must attend classes for the trade that they have chosen to research as their major project.

Assessment/Reinforcement of Main Concepts

Students will submit to the teacher a report that includes a summary of the day in addition to the mathematics they have seen in which it will be important for them to be fluent.

Follow-up

Students could utilize any remaining course time to brush up on areas of mathematics that have been identified as significant to their trade.

Lesson Plan 2 (5 hours—most of this is spent at the work site, with only about 1 hour of actual class time debriefing)

Topic

Job-site Visitation

Outcomes

- demonstrate to others what type of mathematical knowledge is required to be successful at their career choice
- demonstrate competence in the mathematics associated with the specific career choice the student has made

Lesson Summary

In this lesson, students will have the opportunity to visit a job site to spend a day in the atmosphere of the trade that they have identified as interesting.

Materials

Students should discuss with their co-operating tradesperson the materials/clothing/safety gear they will need to bring to help at the job site.

Development

In early April, the student could set up one day in April or May for them to visit a job site. Students must help a skilled tradesperson for one day in the trade that they have chosen to research for their major project. Although Math for the Workplace 12 does not have courses such as Occupational Health and Safety, WHMIS, Emergency First Aid, CPR, or Workplace Safety, students in the course should be encouraged to apply to these courses if they are offered outside of school hours. Some of these are offered online, and others can be taken as day courses. Each of them offers support to students who may be visiting a work place situation during this lesson.

Lesson Plan 3 (3 hours)

Topic

Blueprints

Outcomes

- demonstrate to others what type of mathematical knowledge is required to be successful at their career choice
- demonstrate competence in the mathematics associated with the specific career choice the student has made
- prepare a detailed blueprint for and construct a model which will enable a student to show others some mathematics involved in a specific career interest

Lesson Summary

In this lesson, students will construct blueprints of their model.

Materials

- sample blueprints
- plain white paper
- rulers

Warm-up

Students could have a look at the school blueprints that were discussed in a previous lesson to remind them of the many components that are involved with a blueprint.

Development

A student who has chosen carpentry for their project could draw up plans for building a doghouse or garbage bin. This particular plan should include what lumber will be required to build the model, the plan for each wall, the amount of hardware, the cost breakdown of each item, and the total cost of the project. Other careers will require different models but there should be a practical/tactile component to this major project.

Extensions

Blueprints should have a detailed scale that shows certain conversions needed to obtain materials.

Follow-up

The final project will be compared to the blueprint provided to see that they correspond.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.

Lesson Plan 4 (5 hours – only some of this to be completed in the school)

Topic

Model Construction

Outcomes

- demonstrate to others what type of mathematical knowledge is required to be successful at their career choice
- demonstrate competence in the mathematics associated with the specific career choice the student has made
- prepare a detailed blueprint for and construct a model that will enable a student to show others some mathematics involved in a specific career interest

Lesson Summary

In this lesson, students will seek help from many sources to complete a major project.

Materials

Materials will vary for each student.

Warm-up

A short discussion on tool safety will be necessary.

Development

Students will be expected to spend a considerable amount of their own time on the major project. There will be some class time available, but it will be limited.

Assessment/Reinforcement of Main Concepts

Students would be assessed on their effort, time on task, and the process of proceeding through the project.

Extensions

Students should be able to criticize their projects to see if they could have made them more economically or easier with different measurements.

Follow-up

Students should have a look at the amount of waste produced to see if it could be reduced or reused for another project.

Final Task

With 15 minutes remaining in the class time, assign the homework for the next day and spend the remaining time on *Mastering Essential Math Skills* (Fisher 1998). As suggested in Fisher's handbook, it is important to complete this task each and every day to have students improve upon their basic mathematical and arithmetic skills.