Virginia Western Community College
MTH 154
Quantitative Reasoning

Prerequisites
Competency in MTE 1-5 as demonstrated through placement or unit completion or equivalent OR Corequisite MCR 4: Learning Support for Quantitative Reasoning.

Course Description
Presents topics in proportional reasoning, modeling, financial literacy and validity studies (logic and set theory). Focuses on the process of taking a real-world situation, identifying the mathematical foundation needed to address the problem, solving the problem and applying what is learned to the original situation.

Semester Credits: 3   **Lecture Hours: 3**

Required Materials

Textbook:
Quantitative Literacy: Thinking Between the Lines. Crauder, Evans, Johnson, Noell. 2nd edition. W.H. Freeman. ISBN: 9781483378732.

Other Required Materials:
Scientific Calculator

Course Outcomes

At the completion of this course, the student should be able to:
* Interpret and communicate quantitative information and mathematical and statistical concepts using language appropriate to the context and intended audience.
* Make sense of problems, develop strategies to find solutions, and persevere in solving them.
* Reason, model, and draw conclusions or make decisions with quantitative information.
* Critique and evaluate quantitative arguments that utilize mathematical, statistical, and quantitative information.
* Use appropriate technology in a given context.
* Draw conclusions or make financial decisions using quantitative information.
* Draw conclusions or make decisions based on proportional reasoning.
* Use mathematical methods of analysis to understand the requirements of a problem, create an equation or program that allows prediction and interpretation of quantitative elements of the problem and solution (including limitations of each), and critique the resulting mathematical model for accuracy and validity.
* Identify invalid and unsupported chains of reasoning, and employ methods from the mathematical disciplines of set theory and logic to develop internally consistent arguments and conclusions.

Topical Description

Unit 1: Financial Literacy

Simple Interest
- Define interest and understand related terminology.
- Develop simple interest formula.
- Use simple interest formulas to analyze financial issues

Compound Interest
- Describe how compound interest differs from simple interest.
- Explain the mechanics of the compound interest formula addressing items such as why the exponent and (1+r/n) is used.
- Use compound interest formulas to analyze financial issues
- Show the difference between compound interest and simple interest using a table or graph.

Borrowing
- Compute payments and charges associated with loans.
- Identify the true cost of a loan by computing APR
- Evaluate the costs of buying items on credit
- Compare loans of varying lengths and interest rates.

Investing
- Calculate the future value of an investment and analyze future value and present value of annuities (Take into consideration possible changes in rate, time, and money.)
- Calculate profit from a sale of an investment
- Compare various investment options and understand when it is appropriate utilize them

Unit 2: The Perspective Matters -Number, Ratio, and Proportional Reasoning

- Solve real-life problems requiring interpretation and comparison of complex numeric summaries which extend beyond simple measures of center.
- Solve real-life problems requiring interpretation and comparison of various representations of ratios (i.e., fractions, decimals, rates, and percentages).
- Distinguish between proportional and non-proportional situations and, when appropriate, apply proportional reasoning. Recognize when proportional techniques do not apply.[3]
- Solve real-life problems requiring conversion of units using dimensional analysis.
- Apply scale factors to perform indirect measurements (e.g., maps, blueprints, concentrations, dosages, and densities).
- Order real-life data written in scientific notation. The data should include different significant digits and different magnitudes.

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Unit 3: Modeling

Observation
- Through an examination of examples, develop an ability to study physical systems in the real world by using abstract mathematical equations or computer programs
- Make measurements of physical systems and relate them to the input values for functions or programs. Examples: measure distance and time for a toy car, length of candle and time as it burns, length of vertical spring under different weights attached (linear); temperature and time for a refrigerated liquid as it warms (nonlinear)
- Compare the predictions of a mathematical model with actual measurements obtained
- Quantitatively compare linear and exponential growth
- Explore the mathematical and logical structures that enable familiar models encountered in daily life
    - Weather models
    - Financial models
    - Simple physical models
    - Normal and Exponential Population Models

Mathematical Modeling and Analysis
- Assemble measurements and data gathered (possibly through surveys, internet, etc.) into tables, displays, charts, and simple graphs.
- Explore interpolation and extrapolation of linear and non-linear data. Determine the appropriateness of interpolation and/or extrapolation.
- Identify and distinguish linear and non-linear data sets arrayed in graphs. Identifying when a linear or non-linear model or trend is reasonable for given data or context.
- Correctly associate a linear equation in two variables with its graph on a numerically accurate set of axes
- Numerically distinguish which one of a set of linear equations is modeled by a given set of (x,y) data points
- Identify a mathematical model's boundary values and limitations (and related values and regions where the model is undefined). Identify this as the domain of an algebraic model.
- Using measurements (or other data) gathered, and a computer program (spreadsheet or GDC) to create different regressions (linear and non-linear), determine the best model, and use the model to estimate future values.

Application
- Starting with a verbally described requirement, generate an appropriate mathematical approach to creating a useful mathematical model for analysis
- Explore the graphical solutions to systems of simultaneous linear equations, and their real world applications
- Numerically analyze and mathematically critique the utility of specific mathematical models: instructor-provided, classmate generated, and self-generated

Unit 4: Validity Studies

- Identify logical fallacies in popular culture: political speeches, advertisements, and other attempts to persuade
- Relate the concept of a "statement" to the notion of Truth Value. Identify statements and non-statements
- Describe the differences between verbal expression of truth and mathematical expression of truth. Discuss the usefulness of symbolic representation of statements. Discuss the 2-valued nature of mathematical truth value, relate this to real world examples.

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- Determine the logical equivalence between two different verbal statements (simple and compound) in real-world context.
- Relate the language of conditionals to the language of quantified statements
- Explore the relationship between quantified statements and conditional statements (e.g., "all scientists are educated" is equivalent to "if she is a scientist then she is educated.")
- Apply concepts of symbolic logic and set theory to examine compound statements and apply that to decision making of real-world applications.

Notes to Instructors

Pedagogical and Implementation Recommendations
- Incorporate Problem Based Learning throughout the units that provide students the opportunity to connect mathematical content with their world. This could be in the form of case studies, service learning, article/journal reviews for their future career field, etc.
- While the units are organized by topics, there is much interconnectivity of the outcomes in the units and instructors are encouraged to structure their course presentation in a way they find most appropriate for making connections between the mathematical content and the students' worlds.
- Use of Excel and/or internet based tools to organize information and make calculations is recommended.

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