Arizona Mathematics

# Quantitative Reasoning

## Numerical Reasoning (NR) NR

1. Represent quantities, using equivalent forms when appropriate, to investigate and describe quantitative and geometric relationships and solve problems in real-world contexts. QR.NR.1
2. Reason, model, and communicate with and about percentages (change, incorrect, deceptive, relative and absolute). QR.NR.2
3. Understand and compare magnitudes of numbers utilizing real-world context. Understand the importance and impact of unit selection. QR.NR.3
4. Use and justify estimation skills, and know why, how, and when to estimate results. Assess and justify the reasonableness of estimations using the context and comparisons to other known values. QR.NR.4

## Covariational Reasoning (CR) CR

1. Analyze and compare growth and decay using absolute and relative change utilizing real-world contexts. QR.CR.1
2. Compare, reason and communicate about proportional and non-proportional models utilizing real-world contexts. QR.CR.2
3. Identify, create, and use appropriate models for bivariate data sets (i.e. linear, exponential) to estimate solutions for contextual questions, identify patterns and identify how changing parameters affect the models. QR.CR.3

## Statistical and Probabilistic Reasoning (SPR) SPR

1. Reason and communicate about the validity of claims based on empirical, theoretical, and subjective probabilities. Draw conclusions or make decisions related to risk, pay-off, expected value, and false negatives/positives in various probabilistic contexts. Encompasses P.S-CP.B.9, P.S-MD.A.2, P.S-MD.A.3, P.S-MD.A.4, P.S-MD.B.5, P.S-MD.B.7 QR.SPR.1
2. Analyze statistical information and identify limitations, strengths, or lack of information in studies including data collection methods (e.g. sampling, experimental, observational) and possible sources of bias. Identify errors or misuses of statistics to justify particular conclusions. Encompasses P.S-IC.B.3 QR.SPR.2
3. Represent numerical summaries and visual displays of real-world data to make informed decisions. Reason, communicate, and describe strengths, limitations, and fallacies of various displays. Encompasses P.S-IC.B.6 QR.SPR.3

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| | 4 | **Represent center, shape, and spread of two or more data sets. Reason, communicate, and compare data sets in context.** QR.SPR.4 |
| **Discrete Mathematical Reasoning (DMR)** DMR | 1 | **Understand, analyze, and apply vertex-edge graphs to model and make informed decisions related to paths, circuits, networks, and relationships in real-world settings. Encompasses P.CM-DM.A.1, P.CM-DM.A.2** QR.DMR.1 |
| | 2 | **Devise, analyze, and apply algorithms for solving vertex-edge graph problems. P.CM-DM.A.3** QR.DMR.2 |
| | 3 | **Extend work with adjacency matrices for graphs, such as interpreting row sums and using the nth power of the adjacency matrix to count paths of length n in a graph. P.CM-DM.A.4** QR.DMR.3 |
| **Financial Reasoning (FR)** FR | 1 | **Identify and research a career goal. Develop a plan and time table for achieving it including educational/training requirements, costs, and other factors (e.g. cost versus savings, income and debt).** QR.FR.1 |
| | 2 | **Understand and apply strategies to monitor income and expenses, plan for spending, implement a diversified investment strategy, and save for future goals.** QR.FR.2 |
| | 3 | **Use models to solve and communicate about contextual financial questions such as credit card debt, installment savings, amortization schedules, mortgage and other loan scenarios.** QR.FR.3 |
| | 4 | **Identify and explain personal and societal consequences of financial decisions.** QR.FR.4 |
| **Standards for Mathematical Practice (MP)** MP | 1 | **Make sense of problems and persevere in solving them. Mathematically proficient students explain to themselves the meaning of a problem, look for entry points to begin work on the problem, and plan and choose a solution pathway. While engaging in productive struggle to solve a problem, they continually ask themselves, “Does this make sense?" to monitor and evaluate their progress and change course if necessary. Once they have a solution, they look back at the problem to determine if the solution is reasonable and accurate. Mathematically proficient students check their solutions to problems using different methods, approaches, or representations. They also compare and understand different representations of problems and different solution pathways, both their own and those of others.** QR.MP.1 |

2 **Reason abstractly and quantitatively. Mathematically proficient students make sense of quantities and their relationships in problem situations. Students can contextualize and decontextualize problems involving quantitative relationships. They contextualize quantities, operations, and expressions by describing a corresponding situation. They decontextualize a situation by representing it symbolically. As they manipulate the symbols, they can pause as needed to access the meaning of the numbers, the units, and the operations that the symbols represent. Mathematically proficient students know and flexibly use different properties of operations, numbers, and geometric objects and when appropriate they interpret their solution in terms of the context.** QR.MP.2

3 **Construct viable arguments and critique the reasoning of others. Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents. Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.** QR.MP.3

4 **Model with mathematics. Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. When given a problem in a contextual situation, they identify the mathematical elements of a situation and create a mathematical model that represents those mathematical elements and the relationships among them. Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.** QR.MP.4

5 **Use appropriate tools strategically. Mathematically proficient students consider available tools when solving a mathematical problem. They choose tools that are relevant and useful to the problem at hand. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful; recognizing both the insight to be gained and their limitations. Students deepen their understanding of mathematical concepts when using tools to visualize, explore, compare, communicate, make and test predictions, and understand the thinking of others.** QR.MP.5

6 **Attend to precision. Mathematically proficient students clearly communicate to others using appropriate mathematical terminology, and craft explanations that convey their reasoning. When making mathematical arguments about a solution, strategy, or conjecture, they describe mathematical relationships and connect their words clearly to their representations. Mathematically proficient students understand meanings of symbols used in mathematics, calculate accurately and efficiently, label quantities appropriately, and record their work clearly and concisely.** QR.MP.6

7 **Look for and make use of structure. Mathematically proficient students use structure and patterns to assist in making connections among mathematical ideas or concepts when making sense of mathematics. Students recognize and apply general mathematical rules to complex situations. They are able to compose and decompose mathematical ideas and notations into familiar relationships. Mathematically proficient students manage their own progress, stepping back for an overview and shifting perspective when needed.** QR.MP.7

8 **Look for and express regularity in repeated reasoning. Mathematically proficient students look for and describe regularities as they solve multiple related problems. They formulate conjectures about what they notice and communicate observations with precision. While solving problems, students maintain oversight of the process and continually evaluate the reasonableness of their results. This informs and strengthens their understanding of the structure of mathematics which leads to fluency.** QR.MP.8