

Mathematics Curriculum



Al Jazeera Academy

Doha, Qatar

2010-2011 (DRAFT)

Forward

This document was created by the PYP Coordinator and the Acting Head of Primary at Al Jazeera Academy during the academic year 2010-2011.

The primary sources used for the Standards and Benchmarks were:

- Singapore American School Mathematics Curriculum (April 2009)
- IB Publications – PYP Mathematics Scope & Sequence (2009)
- National Council of Teachers of Mathematics (NCTM) – Principles and Standards of Mathematics

The curriculum is aligned with the PYP mathematics overall expectations in Preschool through Grade 5.

Statement of Beliefs about Teaching and Learning

The purpose of mathematics education is to nurture an ongoing appreciation, enthusiasm, and curiosity for mathematics as all students learn to effectively use mathematics for personal and real life applications, as well as prepare for the demands of a changing, global, technological society where new careers and new knowledge are continually being created.

THE SIX GOALS for all students to develop are:

1. strong mathematical **problem-solving** and reasoning abilities both individually and cooperatively;
2. a firm grounding in essential mathematical **concepts** and **skills**, including computation and estimation;
3. **connections** within mathematics and with other disciplines;
4. the ability to use appropriate **tools** including **technology** to solve mathematical problems;
5. the ability to **communicate** their understanding of mathematics effectively;
6. positive **attitudes** about mathematics.

We believe that mathematical literacy is nurtured through a combination of student centered investigations and teacher-guided instruction. A learning environment that promotes mathematical literacy is made possible in the following six ways:

1. **Equity:** Excellence in mathematics education requires equity: high expectations and strong support for all students. Equity requires accommodating differences to help everyone learn mathematics. High expectations can be achieved in part through engaging and interesting instructional programs that help students see the importance and purpose for mathematics learning in their own lives and the real world. Equity also implies that varied resources are available to appropriately challenge the diverse needs and interests of all students.
2. **Curriculum:** Curriculum is not a listing or collection of activities. Curriculum is intended to clarify what a student is expected to know, understand, and be able to do within meaningful and purposeful mathematical structures of learning. The curriculum must be coherent, focused on important mathematics, and specifically articulated across the grades.
3. **Teaching:** Effective mathematics teaching requires understanding what students know and need to learn, and then challenging and supporting them to learn it well. Improvements within teaching involve continuous learning about mathematics and pedagogy, benefiting from purposeful interactions with students and involvement in results-focused Professional Learning Communities among colleagues, and ongoing professional development and self-reflection.
4. **Learning:** Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge. The alliance of factual knowledge, procedural proficiency, and conceptual understanding are essential to powerful mathematics learning.

5. **Assessment:** Assessment should support the learning of important mathematics and furnish useful information to both teachers and students about progress toward goals. Assessment should be more than merely a test at the end of instruction to see how students perform; rather it should provide varied approaches to assessment (e.g., open-ended questions, constructed response tasks, selected-response items, performance tasks and projects, observations, conversations, journals, portfolios) for also guiding instruction and enhancing student learning and understanding in mathematics.
6. **Technology:** When technology is available, students can use a variety of tools for decision making, reflection, reasoning, and problem solving. Technology can be particularly effective in graphing, visualizing, and computing. Technology is not intended to replace computational skills, but rather to enhance mathematical investigations through a variety of resources (e.g. simulations, internet, spreadsheets, dynamic geometry software, graphing calculators, computer micro-worlds).

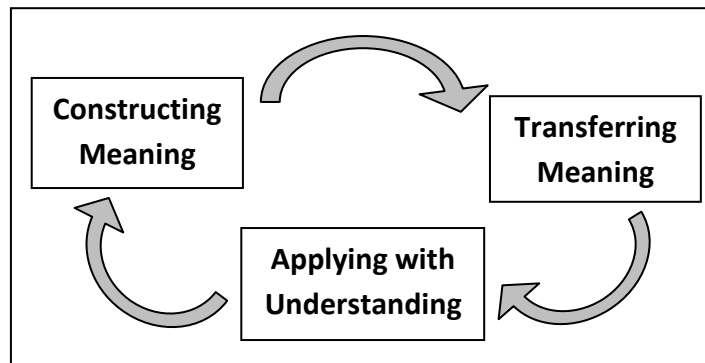
Good Mathematics Practice

It is important that learners acquire mathematical understanding by constructing their own meaning through ever-increasing levels of abstraction, starting with exploring their own personal experiences, understandings and knowledge. Additionally, it is fundamental to the philosophy of the PYP that, since it is to be used in real-life situations; mathematics needs to be taught in relevant, realistic contexts, rather than by attempting to impart a fixed body of knowledge directly to students. How children learn mathematics can be described using the following stages:

- **Constructing Meaning about Mathematics:** Learners construct meaning based on their previous experiences and understanding, and by reflecting upon their interactions with objects and ideas. Therefore, involving learners in an active learning process, where they are provided with possibilities to interact with manipulatives and to engage in conversations with others, is paramount to this stage of learning mathematics. When making sense of new ideas all learners either interpret these ideas to conform to their present understanding or they generate a new understanding that accounts for what they perceive to be occurring. This construct will continue to evolve as learners experience new situations and ideas, have an opportunity to reflect on their understandings and make connections about their learning.
- **Transferring Meaning into Symbols:** Only when learners have constructed their ideas about a mathematical concept should they attempt to transfer this understanding into symbols. Symbolic notation can take the form of pictures, diagrams, modelling with concrete objects and mathematical notation. Learners should be given the opportunity to describe their understanding using their own method of symbolic notation, then learning to transfer them into conventional mathematical notation.
- **Applying with Understanding:** Applying with understanding can be viewed as the learners demonstrating and acting on their understanding. Through authentic activities, learners should independently select and use appropriate symbolic notation to process and record their thinking. These authentic activities should include a range of practical hands-on problem-solving activities and realistic situations that provide the opportunity

to demonstrate mathematical thinking through presented or recorded formats. In this way, learners are able to apply their understanding of mathematical concepts as well as utilize mathematical skills and knowledge.

How students learn mathematics: (Figure 2.2 MTPYPH)



PYP Mathematics Overall Expectations (by the end of Grade 5)

The *Mathematics Scope and Sequence* (2009) has been designed in recognition that learning mathematics is a developmental process and that the phases a learner passes through are not always linear or age related. For this reason the content is presented in continuums for each of the five **strands** of mathematics—Data Handling, Measurement, Shape and Space, Pattern and Function, and Number. The content of each continuum has been organized into four **phases** of development, with each phase building upon and complementing the previous phase. The continuums make explicit the **conceptual understandings** that need to be developed at each phase. Evidence of these understandings is described in the behaviours or **learning outcomes** associated with each phase and these learning outcomes relate specifically to mathematical concepts, knowledge and skills. Additionally, the learning outcomes have been written to reflect the stages a learner goes through when developing conceptual understanding in mathematics—**constructing meaning, transferring meaning into symbols and applying with understanding.**

Data Handling

Phase 1: Learners will develop an understanding of how the collection and organization of information helps to make sense of the world. They will sort, describe and label objects by attributes and represent information in graphs including pictographs and tally marks. The learners will discuss chance in daily events.

Phase 2: Learners will understand how information can be expressed as organized and structured data and that this can occur in a range of ways. They will collect and represent data in different types of graphs, interpreting the resulting information for the purpose of answering questions. The learners will develop an understanding that some events in daily life are more likely to happen than others and they will identify and describe likelihood using appropriate vocabulary.

Phase 3: Learners will continue to collect, organize, display and analyse data, developing an understanding of how different graphs highlight different aspects of data more efficiently. They will understand that scale can represent different quantities in graphs and that mode can be used to summarize a set of data. The learners will make the connection that probability is based on experimental events and can be expressed numerically.

Phase 4: Learners will collect, organize and display data for the purposes of valid interpretation and communication. They will be able to use the mode, median, mean and range to summarize a set of data. They will create and manipulate an electronic database for their own purposes, including setting up spreadsheets and using simple formulas to create graphs. Learners will understand that probability can be expressed on a scale (0–1 or 0%–100%) and that the probability of an event can be predicted theoretically.

Measurement

Phase 1: Learners will develop an understanding of how measurement involves the comparison of objects and the ordering and sequencing of events. They will be able to identify, compare and describe attributes of real objects as well as describe and sequence familiar events in their daily routine.

Phase 2: Learners will understand that standard units allow us to have a common language to measure and describe objects and events, and that while estimation is a strategy that can be applied for approximate measurements; particular tools allow us to measure and describe attributes of objects and events with more accuracy. Learners will develop these understandings in relation to measurement involving length, mass, capacity, money, temperature and time.

Phase 3: Learners will continue to use standard units to measure objects, in particular developing their understanding of measuring perimeter, area and volume. They will select and use appropriate tools and units of measurement, and will be able to describe measures that fall between two numbers on a scale. The learners will be given the opportunity to construct meaning about the concept of an angle as a measure of rotation.

Phase 4: Learners will understand that a range of procedures exists to measure different attributes of objects and events, for example, the use of formulas for finding area, perimeter and volume. They will be able to decide on the level of accuracy required for measuring and using decimal and fraction notation when precise measurements are necessary. To demonstrate their understanding of angles as a measure of rotation, the learners will be able to measure and construct angles.

Shape and Space

Phase 1: Learners will understand that shapes have characteristics that can be described and compared. They will understand and use common language to describe paths, regions and boundaries of their immediate environment.

Phase 2: Learners will continue to work with 2D and 3D shapes, developing the understanding that shapes are classified and named according to their properties. They will understand that examples of symmetry and transformations can be found in their immediate environment. Learners will interpret, create and use simple directions and specific vocabulary to describe paths, regions, positions and boundaries of their immediate environment.

Phase 3: Learners will sort, describe and model regular and irregular polygons, developing an understanding of their properties. They will be able to describe and model congruency and similarity in 2D shapes. Learners will continue to develop their understanding of symmetry, in particular reflective and rotational symmetry. They will understand how geometric shapes and associated vocabulary are useful for representing and describing objects and events in real-world situations.

Phase 4: Learners will understand the properties of regular and irregular polyhedral. They will understand the properties of 2D shapes and understand that 2D representations of 3D objects can be used to visualize and solve problems in the real world, for example, through the use of drawing and modelling. Learners will develop their understanding of the use of scale (ratio) to enlarge and reduce shapes. They will apply the language and notation of bearing to describe direction and position.

Pattern and Function

Phase 1: Learners will understand that patterns and sequences occur in everyday situations. They will be able to identify, describe, extend and create patterns in various ways.

Phase 2: Learners will understand that whole numbers exhibit patterns and relationships that can be observed and described, and that the patterns can be represented using numbers and other symbols. As a result, learners will understand the inverse relationship between addition and subtraction, and the associative and commutative properties of addition. They will be able to use their understanding of pattern to represent and make sense of real-life situations and, where appropriate, to solve problems involving addition and subtraction.

Phase 3: Learners will analyse patterns and identify rules for patterns, developing the understanding that functions describe the relationship or rules that uniquely associate members of one set with members of set. They will understand the inverse relationship between multiplication and division, and the associative and commutative properties of multiplication. They will be able to use their understanding of pattern and function to represent and make sense of real-life situations and, where appropriate, to solve problems involving the four operations.

Phase 4: Learners will understand that patterns can be represented, analysed and generalized using algebraic expressions, equations or functions. They will use words, tables, graphs and, where possible, symbolic rules to analyse and represent patterns. They will develop an understanding of exponential notation as a way to express repeated products, and of the inverse relationship that exists between exponents and roots. The students will continue to use

their understanding of pattern and function to represent and make sense of real-life situations and to solve problems involving the four operations.

Number

Phase 1: Learners will understand that numbers are used for many different purposes in the real world. They will develop an understanding of one-to-one correspondence and conservation of number, and be able to count and use number words and numerals to represent quantities.

Phase 2: Learners will develop their understanding of the base 10 place value system and will model, read, write, estimate, compare and order numbers to hundreds or beyond. They will have automatic recall of addition and subtraction facts and be able to model addition and subtraction of whole numbers using the appropriate mathematical language to describe their mental and written strategies. Learners will have an understanding of fractions as representations of whole-part relationships and will be able to model fractions and use fraction names in real-life situations.

Phase 3: Learners will develop the understanding that fractions and decimals are ways of representing whole-part relationships and will demonstrate this understanding by modelling equivalent fractions and decimal fractions to hundredths or beyond. They will be able to model, read, write, compare and order fractions, and use them in real-life situations. Learners will have automatic recall of addition, subtraction, multiplication and division facts. They will select, use and describe a range of strategies to solve problems involving addition, subtraction, multiplication and division, using estimation strategies to check the reasonableness of their answers.

Phase 4: Learners will understand that the base 10 place value system extends infinitely in two directions and will be able to model, compare, read, write and order numbers to millions or beyond, as well as model integers. They will develop an understanding of ratios. They will understand that fractions, decimals and percentages are ways of representing whole-part relationships and will work towards modelling, comparing, reading, writing, ordering and converting fractions, decimals and percentages. They will use mental and written strategies to solve problems involving whole numbers, fractions and decimals in real-life situations, using a range of strategies to evaluate reasonableness of answers.

Mathematics Standards

1. Read, write, model and compute with whole numbers, decimals and fractions. (Number)
2. Demonstrate an understanding of patterns and mathematical relationships. (Pattern and Function)
3. Identify, describe, draw, build and use 2D and 3D geometric figures and perform simple transformations. (Shape and Space)
4. Recognize and use non-standard and standard units of measurement. (Measurement)
5. Understand and use data and simple probability concepts. (Data Handling)

Mathematics Benchmarks

1. Number:
 - 1.1 understand numbers, ways of representing numbers, relationships among numbers, and number systems;
 - 1.2 understand meanings of operations and how they relate to one another;
 - 1.3 compute fluently and make reasonable estimate.
 - 1.4 use a variety of strategies to solve problems.

2. Pattern and Function:
 - 2.1 understand patterns, relations, and functions;
 - 2.2 represent and analyze mathematical situations and structures using algebraic symbols;
 - 2.3 use mathematical models to represent and understand quantitative relationships;
 - 2.4 analyze change in various contexts.
 - 2.5 use a variety of strategies to solve problems.

3. Shape and Space:
 - 3.1 analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;
 - 3.2 specify locations and describe spatial relationships using coordinate geometry and other representational systems;
 - 3.3 apply transformations and use symmetry to analyze mathematical situations;
 - 3.4 use visualization, spatial reasoning, and geometric modeling to solve problems.
 - 3.5 use a variety of strategies to solve problems.

4. Measurement:
 - 4.1 understand measurable attributes of objects and the units, systems, and processes of measurement;
 - 4.2 apply appropriate techniques, tools, and formulas to determine measurements.
 - 4.3 use a variety of strategies to solve problems.

5. Data Handling
 - 5.1 formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;
 - 5.2 select and use appropriate statistical methods to analyze data;
 - 5.3 develop and evaluate inferences and predictions that are based on data;
 - 5.4 understand and apply basic concepts of probability.
 - 5.5 use a variety of strategies to solve problems.