MATHEMATICS OVERVIEW
GRADES 9 AND 10

Delhi Board of School Education (DBSE)

Directorate of Education, Government of National Capital Territory of Delhi

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ASoSE	Ambedkar School of Specialised Education
DBSE	Delhi Board of School Education
TA	Term-end Assessment
IA	Internal Assessment
IB	International Baccalaureate
IGCSE	International General Certificate of Secondary Education
KP	Knowledge Partners
MYP	Middle Years Programme

1. Introduction to MYP Mathematics

1.1. Importance of Mathematics

Mathematics plays an important role in all walks of life. Whatever we do is steeped in Mathematics. It is omnipresent and beautiful. It is logical, systematic and precise in nature. It is structured and unambiguous. While this system of symbols on the one hand makes mathematics brief, clear and a strong means of expression and communication, on the other hand, this system makes it abstract in nature. This abstractness makes mathematical concepts hard to understand if not presented carefully to the learners.

Mathematics has been around since humans could count and started bartering. Since then, it's evolved right alongside us and is an intrinsic part of our history and culture. Mathematics will be applied immediately to solving real-world problems. By learning mathematics, a student will not only deepen the knowledge of the field but also improve their cognitive and analytical skills and better understand how to solve problems. Knowledge of Mathematics, and its complexities, can help in almost every career. Studying mathematics allows us to understand the world better. Mathematics can unlock the mysteries of the universe. Mathematicians are solving the world's most difficult problems and have been doing so for quite some time.

1.2. Aims of MYP Mathematics

The aims stated below highlight what a teacher may expect to teach and what a student may expect to experience and learn. These aims suggest how students may be changed by the learning experience. The aims of MYP mathematics encourage and enable students to:

- Enjoy mathematics, develop curiosity and begin to appreciate its elegance and power
- Develop an understanding of the principles and nature of mathematics
- Communicate mathematical concepts clearly and confidently in a variety of contexts
- Develop logical, critical and creative thinking skills
- Develop confidence, perseverance, and independence in mathematical thinking and problem-solving
- Develop powers of generalization and abstraction
- Apply and transfer skills to a wide range of real-life situations, other areas of knowledge and future developments
- Appreciate how developments in technology and mathematics have influenced each other
- Appreciate the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics
- Appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives
- Appreciate the contribution of mathematics to other areas of knowledge
- Develop the knowledge, skills and attitudes necessary to pursue further studies in mathematics
- Develop the ability to reflect critically upon their own work and the work of others

1.3. Objectives of Mathematics

The objectives of MYP mathematics encompass the factual, conceptual, procedural and metacognitive dimensions of knowledge and how these objectives relate directly to the assessment criteria.

A. Knowing and understanding: Knowledge and understanding are fundamental to studying mathematics and form the base from which to explore concepts and develop skills. This objective assesses the extent to which students can select and apply mathematics to solve problems in both familiar and unfamiliar situations in a variety of contexts.

In order to reach the aims of mathematics, students should be able to:

i. Select appropriate mathematics when solving problems in both familiar and unfamiliar situations
ii. Apply the selected mathematics successfully when solving problems
iii. Solve problems correctly in a variety of contexts.

B. Investigating patterns: Investigating patterns allows students to experience the excitement and satisfaction of mathematical discovery. Working through investigations encourages students to become risk-takers, inquirers and critical thinkers. The ability to inquire is invaluable and contributes to lifelong learning.

In order to reach the aims of mathematics, students should be able to:

i. Select and apply mathematical problem-solving techniques to discover complex patterns
ii. Describe patterns as general rules consistent with findings
iii. Prove, or verify and justify, general rules.

C. Communicating: Mathematics provides a powerful and universal language. Students are expected to use appropriate mathematical language and different forms of representation when communicating mathematical ideas, reasoning and findings, both orally and in writing.

In order to reach the aims of mathematics, students should be able to:

i. Use appropriate mathematical language (notation, symbols and terminology) in both oral and written explanations
ii. Use appropriate forms of mathematical representation to present information
iii. Move between different forms of mathematical representation
iv. Communicate complete, coherent and concise mathematical lines of reasoning
v. Organize information using a logical structure

D. Applying mathematics in real-life contexts: Mathematics encourages students to see mathematics as a tool for solving problems in an authentic real-life context. Students are expected to transfer theoretical mathematical knowledge into real-world situations and apply appropriate problem-solving strategies, draw valid conclusions and reflect upon their results.

In order to reach the aims of mathematics, students should be able to:

i. Identify relevant elements of authentic real-life situations
ii. Select appropriate mathematical strategies when solving authentic real-life situations
iii. Apply the selected mathematical strategies successfully to reach a solution
iv. Justify the degree of accuracy of a solution
v. Justify whether a solution makes sense in the context of the authentic real-life situation

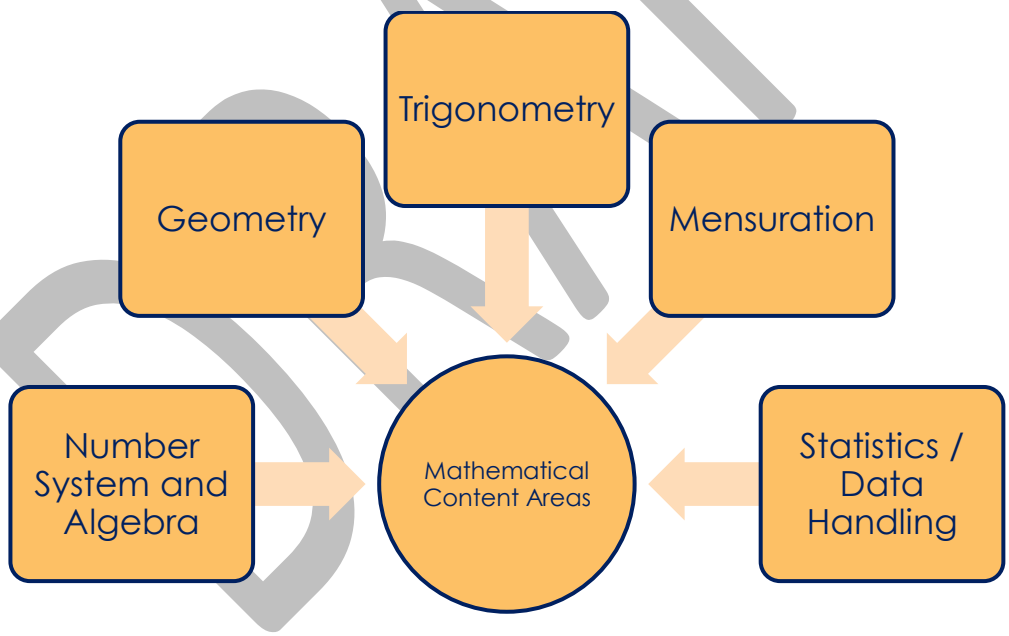
2. Mathematics as a subject

2.1. Sub-domains in Mathematics

Practicing Mathematics ensures the development of all domains of an individual's personality. An individual develops into a balanced person across three domains: the cognitive, affective and psychomotor domains. Mathematics facilitates the process of developing an independent and conscious human ready to serve society with sustainably.

Mathematical abilities and skills develop gradually over years of growth in a spiral form. An individual acquires these abilities and skills in familiar and unfamiliar situations comprising a formal and informal environment. Quantitative reasoning, logical reasoning, analytical ability, spatial reasoning and communication are the skills developed through focussing and experiencing Mathematical learning spaces.

The mathematical concepts can be categorized majorly as Numbers and Number Operations, Algebra, Data handling. Measurement and Spatial Thinking.



2.1.1 NUMBER SYSTEM & ALGEBRA

The Number System enables us to keep count of all the things. It enables the unique and accurate representation of different types of numbers. Computation of any kind of interest on amounts deposited in banks, creation of passwords on computers, other security purposes, every fibre of data stored on computers is based on numbers. Even elevators used in public places also depend upon number systems for their functioning.

By learning Algebra, we can gain a better appreciation for human history. It helps describe so many types of real-world phenomena from gravity to the growth of populations or organisms. There are other subjects that require an understanding of math and algebra in particular. Algebra is needed in domains of mathematics like geometry, calculus, and trigonometry as well. Algebra allows us to take

any formula, plug in numbers, and solve an equation. It helps us reach a generalized formula, while we combine and simplify over and over until we have one value for each variable. Algebra is used in nearly every aspect of technology, which includes how smartphones and computers operate. Algebra can help us in our everyday life, in budget-making, analysis of spending habits allowing us to take wiser decisions with our spending.

2.1.2 GEOMETRY

Geometry is the most influential branch of mathematics. It helps one understand the personal and cultural expression of the world and appreciate it. It enables us to understand and have knowledge of spaces, like areas in relation related to space and the position, sizes and shapes, surfaces, volumes, lines, angles, etc. It is the bedrock of architecture and even things like puzzle-design or book-design. Geometry introduces various important formulas, such as the Pythagorean theorem, which are used across science and math concepts.

2.1.3 TRIGONOMETRY

Trigonometry is the study of the relationships between angles, lengths and heights. It is used in astronomy and geography. Trigonometry is applicable to various fields of study like satellite navigation, electronic music production, chemistry number theory, medical imaging, electronics, electrical engineering, civil engineering, architecture, mechanical engineering, oceanography, seismology, phonetics, image compression and game development. Trigonometry is used to measure the height of a building or a mountain. The distance of a building from a viewpoint and the elevation angle can easily determine the height of a building using trigonometric functions.

2.1.4 MENSURATION

Mensuration is a prominent concept of Mathematics and studies the measurement of different geometric shapes and figures. It helps us understand the dimensions of various 2-dimensional and 3-dimensional objects. It is concerned with exploring personal histories and journeys by looking at the kinds of vessels used in homes, their relationships between, and the interconnectedness of individuals and civilizations.

2.1.5 STATISTICS/ DATA HANDLING

Data Handling is the process of gathering, recording, and presenting information in a way that allows others to access information easily or quickly, through graphs or charts. This domains is also known as statistics. It is used to compare data and make inferences by analysing this data. It decreases the time consumed to search for required information. It helps to reduce data loss and errors. It is our responsibility to use data in a way that doesn't create or reinforce biases.

Students need statistics to help them judge the correctness of an argument supported by seemingly persuasive data. Probability is the study of random events. It is used to analyse games of chance, genetics, weather predictions, and a myriad of other everyday events.

2.2. Key Concepts in mathematics

IB recommends using key concepts [1]as a linkage between different sub-domains of mathematics. These key concepts also help in linking mathematics skills with skills other academic subjects. The key concepts used in sub-domains of mathematics for grades IX and X are given in the below tables.

[1] International Baccalaureate Organization.2017. Mathematics subject guide

Table 1: Key Concepts in grade IX

Grade IX	
Sub-domains	**Key Concepts**
1. Number system	Logic[2]
2. Algebra	Logic
3. Geometry	Relationship[3]
4. Mensuration	Form[4]
5. Trigonometry	Relationship
6. Data Handling	Logic

Table 2: Key Concepts in grade X

Grade X	
Sub-domains	**Key Concepts**
1. Algebra	Logic
2. Number System	Logic
3. Geometry	Relationship
4. Mensuration	Form
5. Trigonometry	Relationship
6. Data Handling	Logic

[2] Logic is a method of reasoning and a system of principles used to build arguments and reach conclusions.

[3] Relationships are the connections and associations between properties, objects, people and ideas—including the human community's connections with the world in which we live. Any change in relationship brings consequences—some of which may occur on a small scale, while others may be far reaching, affecting large networks and systems such as human societies and the planetary ecosystem.

[4] Form is the shape and underlying structure of an entity or piece of work, including its organization, essential nature and external appearance.

3. Mathematics curriculum overview for grades IX and X

An academic year at DBSE consists of two terms. Grade IX and X curriculum is clustered into 6 units. These units are delivered in two terms of an academic year. Unit names, content, duration and related learning resources are provided in subsequent sections.

3.1. Grade IX curriculum overview

Table 3: Unit names, content, duration and the learning resources in grade IX units

Grade IX			
Term 1			
Unit	**Content**	**Duration**	**Resources**
Number System	• Rational numbers • Irrational Numbers • Representation on the Number Line • Rationalization • Laws of Exponents	4 weeks	• Pedagogic Companion • Student Companion • NCERT, e-Pathshala • DIKSHA PORTAL
Algebra	• Polynomial, • Coordinate • Geometry, • Linear Equation in two Variables	6 weeks	
Trigonometry	• Introduction to Trigonometry • Trigonometric Identities	2 weeks	
Term 2			
Geometry	• Euclid Geometry • Lines & Angles • Triangles • Quadrilaterals • Area of Triangles & Parallelograms • Circles • Constructions	7 weeks	• Pedagogic Companion /Student Companion • NCERT, e-Pathshala • DIKSHA PORTAL • Geo-Gebra • Desmos
Mensuration	• Heron Formula • Surface area and volume	5 weeks	
Data Analysis and Probability	• Statistics • Probability	3 weeks	

3.2. Grade X curriculum overview

Table 4: Unit names, content, duration and the learning resources in grade X units

Grade X			
Term 1			
Unit	**Content**	**Duration**	**Resources**
Algebra	• System of linear equation in two variables • Polynomials in one variable • Quadratic Equations • Arithmetic Progression	6 weeks	• Pedagogic Companion • Student Companion • NCERT, e-Pathshala • DIKSHA PORTAL
Number System	• Sets • Real numbers • Euclid algorithm for HCF and LCM	4 weeks	
Geometry	• Magnifying 2D geometry • Circles • Practical Geometry • Coordinate Geometry	6 weeks	
Term 2			
Mensuration	• Euclid Geometry • Lines & Angles • Areas related to circles and combination of different 2D figures • Volume & Surface Area of section of prisms, pyramids • Volume and surface area of sphere, hemisphere • Combination of different solid shapes	5 weeks	• Pedagogic Companion • Student Companion • NCERT, e-Pathshala • DIKSHA PORTAL • Geo-Gebra • Desmos
Trigonometry	• Application of Trigonometry and combining all space in one	4 weeks	
Data Handling	• Statistics: central tendencies and graphical representation of grouped data • Probability: empirical or experimental probability and classical probability	3 weeks	

4. Assessment Overview

DBSE approach to assessment and reporting is based on the IB specified assessment criteria and grades. Criterion based assessments enable students to self-monitor and build self-belief as they can see the evidence of the progress they are making over time. Students can track their progress using level descriptors, they can clearly understand how their work can be improved over time.

The four core criteria assessed in mathematics are:

- Criterion A – Knowing and understanding
- Criterion B – Investigating patterns
- Criterion C – Communicating
- Criterion D – Applying mathematics in real-life contexts

DBSE promotes multiple ways of assessing students. There are three types of assessments conducted at DBSE schools throughout a learning period.

Assessment for learning: It is the process of gathering and interpreting evidence for use by students and teachers to know where the students are on their learning pathway, decide where they need to go and how best to get there. The teacher plays a supportive role wherein the student responses in the assessment tasks are analysed to help students progress on their learning pathway. Consequently, it is important that these assessments must always be accompanied by feedback and feed-forward mechanisms to enable deep learning and help improve teaching. Example tasks include homework, classwork, class tests, assignments, projects, etc. The assessments should provide the right amount of challenge to students based on learning levels so that appropriate feedback can be provided.

Assessment of learning: It takes place at key points in the learning cycle, such as at the end of a learning period, e.g. a term, to measure if students have achieved the learning objectives. Example tasks include exams, final projects, essays, etc. The primary purpose is to assess what students can do at a point in time to understand their readiness to move to the next stage of education.

Assessment as learning: Students are provided with opportunities to monitor their own progress, self-assess and reflect on their learning. Example tasks include self-assessment, peer assessment, student portfolio, etc.

The assessment tasks and methods used in internal assessment are criterion related, student-centric and provide feedback for further enhancement of learning. There are two types of assessments used for reporting student performance.

- Internal assessments (IA) (20%)
- Term-end assessments (TA) (80%)

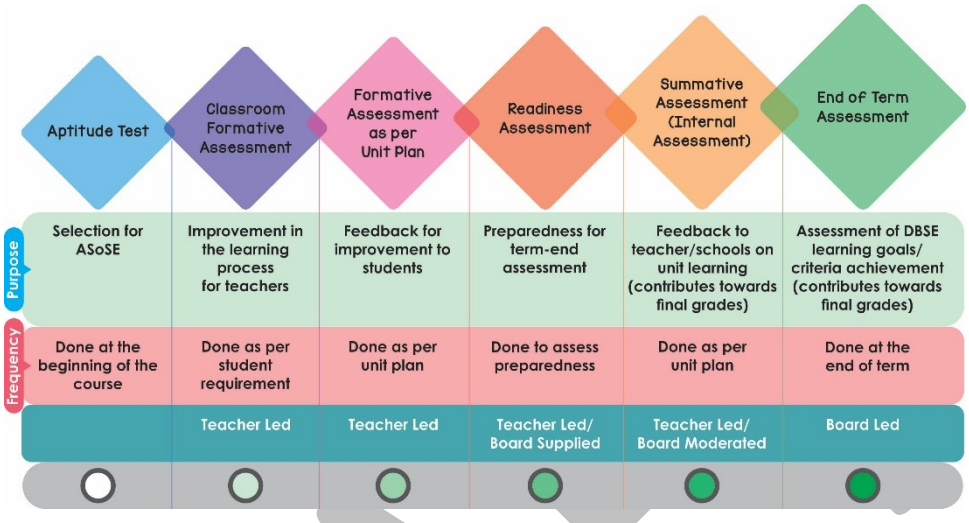
The assessment tasks and methods used in internal assessments provide opportunities for students to show their academic achievements in multiple ways and provide feedback for further enhancement of learning. External assessment tasks are based on curriculum objectives defined for mathematics.

DBSE assessments used for reporting for grades 9 & 10 can be school-led and/or board-led. School-led assessments are based on an item pool provided by DBSE and Board-led assessments are developed and administered by DBSE. In grade 10, DBSE monitor internal assessments and readiness assessments. Term-end assessments are conducted by DBSE.

4.1. Assessment structure

Global best practices suggest a multifaceted assessment structure. That is, students should be assessed in multiple ways and at multiple times without increasing the workload of teachers or students, to the extent possible. A schematic representation of the DBSE assessment structure is presented below:

Figure 1: Assessments in DBSE



4.2. Assessment calendar

The assessment calendar for internal and external assessments for academic year 2022- 23 grade 9 assessments is given below.

Table 5: Grade IX assessment calendar

Unit	Duration		Assessment	Criteria Assessed	Assessment Strategies
1	4-Jul	30-Jul	IA - Unit 1 Summative	A: Knowledge and understanding C: Communicating	• Mathematical essay • Case Studies • MCQs • Problem solving • Project • Mathematical skits • Mathematical extempore • Research work
2	1-Aug	10-Sep	IA - Unit 2 Summative	A: Knowledge and understanding D: Applying mathematics in real life	
3	12-Sep	24-Sep	IA - Unit 3 Summative	B: Investigating patterns D: Applying mathematics in real life	
10 – 24 October 2022			**Term-end 1**	**All 4 Criteria**	**Competency based assessment**
4	31-Oct	17-Dec	IA - Unit 4 Summative	B: investigating patterns C: Communicating	• Mathematical essay • Case Study • MCQs • Problem solving • Project with presentation • Mathematical skits • Mathematical extempore
5	19-Dec	4-Feb	IA - Unit 5 Summative	A: Knowledge and understanding D: Applying mathematics	
6	6-Feb	25-Feb	IA - Unit 6 Summative	C: Communicating Criterion B: investigating patterns	
1 - 20 March 2023			**Term-end 2**	**All 4 Criteria**	**Competency based assessment**

Table 6: Grade X assessment calendar

Unit	Duration		Assessment	Criteria Assessed	Assessment Strategies
1	4-Apr	13-May	IA - Unit 1 Summative	A: Knowledge and understanding C: Communicating	• Mathematical essay • Case Study • MCQs • Problem solving • Project • Mathematical skits • Mathematical • extempore • Research work
2	16-May	20-Jul	IA - Unit 2 Summative	A: Knowledge and understanding D: Applying mathematics in real life	
3	25-Jul	10-Sep	IA - Unit 3 Summative	B: Investigating patterns Criterion D: Applying mathematics in real life	
12 to 24 September 2022			Readiness Assessment	Criterion A; Criterion B; Criterion C; Criterion D	Competency based assessment
10 – 24 October 2022			**Term-end 1**	**All 4 Criteria**	**Competency based assessment**
4	31-Oct	3-Dec	IA - Unit 4 Summative	B: Investigating patterns C: Communicating	• Mathematical essay • Case Study • MCQs • Problem solving • Project with presentation • Mathematical skits • Mathematical extempore
5	5-Dec	31-Dec	IA - Unit 5 Summative	A: knowledge and understanding Criterion D: Applying mathematics	• Mathematical essay • Case Study • MCQs • Problem solving • Project with presentation • Mathematical skits • Mathematical extempore
6	16-Jan	3-Feb	IA - Unit 6 Summative	C: Communicating B: Investigating patterns	
19 - 31-December 2022			Readiness Assessment	All 4 Criteria	Competency based assessment
1 - 20 March 2023			**Term-end 2**	**All 4 Criteria**	**Competency based assessment**

4.3. Assessment levels and grades

The Assessment Criteria directly relate to the Objectives of the mathematics curriculum and carry equal weightage. The student achievement levels will be reported as a number grade as done in IB with an associated description.

The grade descriptions are based on assessment criteria levels. The level descriptors of an assessment criterion depict clear progression of improvement of skills and competencies for a learning period.

All the assessment tasks used to report students' achievements are based on task specific, hierarchical, and qualitatively defined rubrics. The categories used in rubrics represent increasing quality or sophistication of response to a task. They provide a basis for evaluating and recording students' responses to an assessment task. A rubric makes assessment expectations transparent.

In order to show the degree of competence in each criterion, fine grained descriptions of various levels are used. These descriptions indicate the progression of achievement in each criterion. IB mathematics criteria levels and grade descriptions are given in the following tables

Table 7: Criterion A: Knowing and understanding

Levels	Level Description
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. select appropriate mathematics when solving simple problems in familiar situations ii. apply the selected mathematics successfully when solving these problems iii. generally solve these problems correctly in a variety of contexts
3-4	The student is able to: i. select appropriate mathematics when solving more complex problems in familiar situations ii. apply the selected mathematics successfully when solving these problems iii. generally solve these problems correctly in a variety of contexts.
5-6	The student is able to: i. select appropriate mathematics when solving challenging problems in familiar situations ii. apply the selected mathematics successfully when solving these problems iii. generally solve these problems correctly in a variety of contexts.
7-8	The student is able to: i. select appropriate mathematics when solving challenging problems in both familiar and unfamiliar situations ii. apply the selected mathematics successfully when solving these problems iii. generally solve these problems correctly in a variety of contexts.

Table 8: Criterion B: Investigating patterns

Levels	Level Description
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. apply, with teacher support, mathematical problem-solving techniques to discover simple patterns ii. state predictions consistent with patterns
3-4	The student is able to: i. apply mathematical problem-solving techniques to discover simple patterns ii. suggest general rules consistent with findings.
5-6	The student is able to: i. select and apply mathematical problem-solving techniques to discover complex patterns ii. describe patterns as general rules consistent with findings iii. verify the validity of these general rules
7-8	The student is able to: i. select and apply mathematical problem-solving techniques to discover complex patterns ii. describe patterns as general rules consistent with correct findings iii. prove, or verify and justify, these general rules

Table 9: Criterion C: Investigating patterns

Levels	Level Description
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. use limited mathematical language ii. use limited forms of mathematical representation to present information iii. communicate through lines of reasoning that are difficult to interpret.
3-4	The student is able to: i. use some appropriate mathematical language ii. use appropriate forms of mathematical representation to present information adequately iii. communicate through lines of reasoning that are complete iv. adequately organize information using a logical structure.
5-6	The student is able to: i. usually use appropriate mathematical language ii. usually use appropriate forms of mathematical representation to present information correctly iii. usually move between different forms of mathematical representation iv. communicate through lines of reasoning that are complete and coherent v. present work that is usually organized using a logical structure.
7-8	The student is able to: i. consistently use appropriate mathematical language ii. use appropriate forms of mathematical representation to consistently present information correctly iii. move effectively between different forms of mathematical representation iv. communicate through lines of reasoning that are complete, coherent and concise v. present work that is consistently organized using a logical structure.

Table 10: Criterion D: Applying mathematics in real-life contexts

Levels	Level Description
0	The student does not reach a standard described by any of the descriptors below.
1-2	The student is able to: i. apply, with teacher support, mathematical problem-solving techniques to discover simple patterns ii. state predictions consistent with patterns
3-4	The student is able to: i. identify the relevant elements of the authentic real-life situation ii. select, with some success, adequate mathematical strategies to model iii. the authentic real-life situation iv. apply mathematical strategies to reach a solution to the authentic real-life situation v. discuss whether the solution makes sense in the context of the authentic real-life situation.
5-6	The student is able to: i. identify the relevant elements of the authentic real-life situation ii. select adequate mathematical strategies to model the authentic real-life situation iii. apply the selected mathematical strategies to reach a valid solution to the authentic real-life situation iv. explain the degree of accuracy of the solution v. explain whether the solution makes sense in the context of the authentic real-life situation.
7-8	The student is able to: i. identify the relevant elements of the authentic real-life situation ii. select appropriate mathematical strategies to model the authentic real-life situation iii. apply the selected mathematical strategies to reach a correct solution to the authentic real-life situation iv. justify the degree of accuracy of the solution v. justify whether the solution makes sense in the context of the authentic real-life situation.

Table 11: Description of Grade points

Grade	Grade Description
7	Produces high-quality work that frequently uses mathematics insightfully. Communicates comprehensive, nuanced understanding of concepts and contexts demonstrating proficient application of mathematical techniques and terminology. Consistently demonstrates sophisticated analytical thinking and logical processes when problem-solving and investigating. Frequently transfers mathematical knowledge and applies skills, with independence and expertise, in a variety of complex classroom and real-world situations.
6	Produces high-quality, occasionally insightful mathematical work. Communicates extensive understanding of concepts and contexts demonstrating proficient application of mathematical techniques and terminology. Demonstrates analytical thinking and logical processes, frequently with sophistication when problem-solving and investigating. Transfers mathematical knowledge and applies skills, often with independence, in a variety of familiar and unfamiliar classroom and real-world situations
5	Produces generally high-quality mathematical work. Communicates good understanding of concepts and contexts demonstrating proficient application of mathematical techniques and terminology. Demonstrates analytical thinking and logical processes, sometimes with sophistication, when problem-solving and investigating. Usually transfers mathematical knowledge and applies skills, with some independence, in familiar classroom and real-world situations.
4	Produces good-quality mathematical work. Communicates basic understanding of most concepts and contexts with evidence of appropriate application of mathematical techniques and terminology, with few misunderstandings and minor gaps. Often demonstrates analytical thinking when problem-solving and investigating. Transfers some mathematical knowledge and applies skills in familiar classroom situations, but requires support in unfamiliar situations.
3	Produces mathematical work of an acceptable quality. Communicates basic understanding of many concepts and contexts with occasional evidence of appropriate application of mathematical techniques and terminology, with occasional significant misunderstandings or gaps. Begins to demonstrate some analytical thinking when problem-solving and investigating. Begins to transfer mathematical knowledge and apply skills, requiring support even in familiar classroom situations.
2	Produces mathematical work of limited quality. Communicates limited understanding of some concepts and contexts. Demonstrates limited evidence of mathematical thinking. Limited evidence of transfer of mathematical knowledge and application of skills.
1	Produces work of a very limited quality. Conveys many significant misunderstandings or lacks understanding of most concepts and contexts. Very rarely demonstrates evidence of mathematical thinking. Very inflexible, rarely shows evidence of knowledge or skills.