Introduction

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Purpose of Document

This document is intended to support teachers of Grade 10 Introduction to Applied and Pre-Calculus (IAP) Mathematics students. Its purpose is to help teachers facilitate students' revisiting (or spiralling) outcomes across multiple grade levels by connecting student prior knowledge with current grade-level content. The content provides opportunities for Grade 10 IAP students to become more proficient in problem solving, and to build their knowledge of and make multiple connections to their prior learning. Revisiting outcomes will help students solidify their understanding of important mathematical concepts and procedures across prior grades to enable them to achieve at higher levels with current grade-level mathematics content.

For some students, the content of the document may provide some students new opportunities and experiences to understand more deeply the mathematical concepts they encountered in prior grades. The experience gained by students working through the content of this support document will aid their successful transition into Grade 11 mathematics.

Background

Feedback received from post-secondary institutions in Manitoba has highlighted the need for support to ease students' transition from secondary to post-secondary school. Teachers have shared a similar concern when talking about student transition within the public school system. Specifically, some students have difficulty applying and connecting content from prior grades to the content currently under study. By design, the Western and Northern Canadian Protocol (WNCP)–approved resources for Manitoba curricula do not include content related to prior learning. As a result, unless teachers find supplemental material, students may not have enough experience with some concepts to see how they connect to prior learning and to develop a deep understanding. Used alongside the approved text resources, this support document gives students an opportunity to revisit prior learning, build experiences, and facilitate a deeper understanding of grade-level concepts.

Rationale

National Council of Teachers of Mathematics (NCTM) research supports the idea of students being given the opportunity to revisit (or spiral) and connect concepts across multiple grade levels to solidify their understanding. Anthony and Walshaw identify "making connections" as one of the strategies for effective pedagogy in mathematics. "Tasks that require students to make multiple connections within and across topics help them appreciate the interconnectedness of different mathematical ideas and the relationships that exist between mathematics and real life" (p. 15). Teachers want their students to have good conceptual understanding of mathematics topics and be fluent with procedures. "Fluency builds from initial exploration and discussion of number concepts to using informal reasoning strategies based on meanings and properties of the operations to the eventual use of general methods as tools in solving problems" (NCTM, p. 42). Students need foundational experiences that give meaning and understanding of procedures.

> In moving to fluency, students also need opportunities to rehearse or practice strategies and procedures to solidify their knowledge. …Students need opportunities to practice on a moderate number of carefully selected problems after they have established a strong conceptual foundation and the ability to explain the mathematical basis for a strategy or procedure (Pashler et al.; Rohrer, Rohrer and Taylor) (NCTM, p. 45).

There is a need for practice. A moderate amount of problems should be carefully selected to stress concept development and reveal possible misconceptions.

> If teachers want students to be proficient in problem solving, students must be given opportunities to practice problem solving. If strong deductive reasoning is a goal, student work must include tasks that require such reasoning. And, of course, if competence in procedures is an objective, the curriculum must include attention to such procedures. (Grouws and Cebulla, p. 17)

> To increase opportunities for invention, teachers should frequently use non-routine problems, periodically introduce a lesson involving a new skill by posing it as a problem to be solved, and regularly allow students to build new knowledge based on their intuitive knowledge and informed procedures. (Grouws and Cebulla, p. 18)

The questions created for this document will encourage students' continuing development of number sense, will give them opportunities to practise and deepen their prior learning, and will provide non-routine problems to encourage students to think and communicate about mathematics.

Beliefs about Student and Mathematics Learning

Students are curious, active learners with individual interests, abilities, needs, and career goals. They come to school with varying knowledge, life experiences, expectations, and backgrounds. A key component in developing mathematical literacy in students is making connections to these backgrounds, experiences, goals, and aspirations. Students construct their understanding of mathematics by developing meaning based on a variety of learning experiences.

This meaning is best developed when learners encounter mathematical experiences that proceed from simple to complex and from the concrete to the abstract. The use of manipulatives, visuals, and a variety of pedagogical and assessment approaches can address the diversity of learning styles and developmental stages of students. At all levels of understanding, students benefit from working with a variety of materials, tools, and contexts when constructing meaning about new mathematical ideas. Meaningful student discussions also provide essential links among concrete, pictorial, and symbolic representations of mathematics.

Students need frequent opportunities to develop and reinforce their conceptual understanding, procedural thinking, and problem-solving abilities. By addressing these three interrelated components, students will strengthen their ability to apply mathematical learning to their daily lives.

The learning environment should value, respect, and address all students' experiences and ways of thinking so that students are comfortable taking intellectual risks, asking questions, and posing conjectures. Students need to explore mathematics through solving problems in order to continue developing personal strategies and mathematical literacy. It is important to realize that it is acceptable to solve problems in different ways and that solutions may vary depending upon how the problem is understood.

Assessment *for* learning, assessment *as* learning, and assessment *of* learning are all critical to helping students learn mathematics. A variety of evidence and a variety of assessment approaches should be used in the mathematics classroom.

First Nations, Métis, and Inuit Perspectives

First Nations, Métis, and Inuit students in Manitoba come from diverse geographic areas and have varied cultural and linguistic backgrounds. Students attend schools in a variety of settings, including urban, rural, and isolated communities. Teachers need to recognize and understand the diversity of cultures within schools and the diverse experiences of students.

First Nations, Métis, and Inuit students often have a whole-world view of the environment; as a result, many of these students live and learn best in a holistic way. This means that students look for connections in learning and learn mathematics best when it is contextualized and not taught as discrete content.

Many First Nations, Métis, and Inuit students come from cultural environments where learning takes place through active, hands-on participation. Traditionally, little or no emphasis was placed upon the written word. Oral communication, along with practical applications and experiences, is important to student learning and understanding.

A variety of teaching and assessment strategies are required to build upon the diverse knowledge, cultures, communication styles, skills, attitudes, experiences, and learning styles of students.

The strategies used must go beyond the incidental inclusion of topics and objects unique to a culture or region and strive to achieve higher levels of multicultural education (Banks and Banks).

Affective Domain

A positive attitude is an important aspect of the affective domain that has a profound effect on learning. Environments that create a sense of belonging, support risk taking, and provide opportunities for success help students to develop and maintain positive attitudes and self-confidence. Students with positive attitudes toward learning mathematics are likely to be motivated and prepared to learn, to participate willingly in classroom activities, to persist in challenging situations, and to engage in reflective practices.

Teachers, students, and parents need to recognize the relationship between the affective and cognitive domains and to nurture those aspects of the affective domain that contribute to positive attitudes. To experience success, students must be taught to set achievable goals and assess themselves as they work toward these goals.

Autonomous and responsible learners are engaged in ongoing, reflective processes that involve revisiting the setting and assessing of personal goals.

Goals for Students

The main goals of mathematics education are to prepare students to

- communicate and reason mathematically
- use mathematics confidently, accurately, and efficiently to solve problems
- appreciate and value mathematics
- make connections between mathematical knowledge and skills and their applications
- commit themselves to lifelong learning
- become mathematically literate citizens, using mathematics to contribute to society and to think critically about the world

Students who have met these goals

- gain an understanding and appreciation of the role of mathematics in society
- exhibit a positive attitude toward mathematics
- engage and persevere in mathematical problem solving
- contribute to mathematical discussions
- take risks in performing mathematical tasks
- exhibit curiosity about mathematics and situations involving mathematics

In order to assist students in attaining these goals, teachers are encouraged to develop a classroom atmosphere that fosters conceptual understanding through

- taking risks
- thinking and reflecting independently
- sharing and communicating mathematical understanding
- solving problems in individual and group projects
- pursuing greater understanding of mathematics
- appreciating the value of mathematics throughout history

Mathematical Processes

The seven mathematical processes are critical aspects of learning, doing, and understanding mathematics. Students must encounter these processes regularly in a mathematics program in order to achieve the goals of mathematics education. *Grades 9 to 12 Mathematics: Manitoba Curriculum Framework of Outcomes* incorporates the following interrelated mathematical processes. It is intended that they permeate the teaching and learning of mathematics. Students are expected to

- use communication in order to learn and express their understanding
- make connections among mathematical ideas, other concepts in mathematics, everyday experiences, and other disciplines
- demonstrate fluency with mental mathematics and estimation
- develop and apply new mathematical knowledge through problem solving
- develop mathematical reasoning
- select and use technology as a tool for learning and solving problems
- develop visualization skills to assist in processing information, making connections, and solving problems

All seven processes should be infused in the teaching and learning of mathematics. Students will encounter these processes through the content of this support document. For a detailed description of each mathematical process, refer to *Grades 9 to 12 Mathematics: Curriculum Framework of Outcomes* (available on the Manitoba Education website at www.edu.gov.mb.ca/k12/cur/math/framework_9-12/index.html).