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Comparative Analysis of Content, Organization, and Presentation of Mathematical Concepts in Canadian and Japanese Grade Fifth Textbooks

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Abstract: The purpose of this study was to examine how Canadian and Japanese fifth-grade mathematics textbooks addressed the topics, rote learning by memorization and conceptual understanding facets of teaching. Based on the comparison, it appears that both textbooks cover the required content for a grade 5 student based on the curriculum in the intended subject area. Regarding topics covered and content presentation, the Japanese textbook provides a more engaging and, overall, more successful approach to teaching student's mathematical content. With student-driven differentiated instruction and open-ended questions, students can better engage with learning through an easy-to-follow textbook filled. With extras, students have the information they require to solve questions and understand examples. Elements of visual design once again predominate within the Japanese math textbook through the various characters, visual aids, and overall colour choice for the visual aspect of the textbook promote student engagement and help create positive emotions in mathematical content, which helps students create better learning relationships with the content being taught. Overall, the research finds that regarding the impact of students learning through the textbooks, the Japanese textbook has the advantage for student learning. However, from a teaching perspective, the Japanese open-ended student lead approach is more complex, which means if not properly taught, it could limit the success of the textbook and student learning. The Ontario textbook is still a comparable book, but making the textbook more engaging visually could improve students' overall performance when being taught with this book in the classroom.

Keywords: Textbooks; Mathematics; Memorization; Content Comparison; Conceptual Understanding.

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Introduction

Mathematics is heavily emphasized course of study throughout schools and yet remains one of the most challenging for students to understand. It can often be seen as very abstract for students, especially as they get older and start to work on problems or with formulas which they don't feel a direct connection to their personal and everyday life. Teachers who may have had or still have problems with mathematical concepts often rely strongly on pre-made materials to instruct their mathematics lessons to avoid misconceptions in teaching. Textbooks have been formulated to help guide teachers and their students in attaining curriculum expectations and to allow the students to practice their knowledge through a series of questions and activities. Researches indicate that school textbooks remain an important and decisive component as they correlate with student achievement scores and provide a structural framework of local curriculum for classroom teachers (Hadar 2017; Horsley & Sikirova, 2015; Stara et al., 2017).

Throughout the subject of mathematics, there are constantly varying levels of success. Could the textbooks themselves impact the success of the students? How might the book's layouts affect the student's understanding of the material? Although much research has been conducted between Canada and other countries in the field of comparative education

and curriculum, the number of researches in the field of comparative study of textbooks is limited. In the current study, Japan is chosen because the students of this country obtained high ranks in international tests, and also despite the fact that school textbooks in Canada are chosen by the teachers, Addison Wesley's Math Makes Sense remains one of the most popular choices for teaching mathematics in schools. The main goal of this research is a comparative study of conceptual understanding and memorization in the Grade five mathematics textbooks of Japan and Canada.

Significance of the Study

It begs the question of why a Canadian textbook should be compared to a Japanese textbook. The Trends in International Mathematics and Science Study (TIMSS) is a cross-country comparative analysis that measures 4th and 8th grade scores in mathematics and science in every four years (TIMSS & PIRLS International Study Center at Boston College, 2019). According to the 2019 TIMSS report, Japan scored 5th overall in the grade 4 test comprehension, while Canada scored 32nd in the same report (TIMSS & PIRLS, 2019). Continuously, Japan continues to exceed TIMSS benchmark scores and demonstrate their use of pedagogical strategies and educational philosophies in crafting consistently proficient mathematics students. Thus, this textbook analysis serves a purpose in evaluating and quantifying the major differences among Canadian and Japanese pedagogy found in mathematics textbooks. Consequently, these results can help direct future instruction in Canadian classrooms and support the province of Ontario's steadily declining math performance, which decreased from 50% of students at or above provincial standards in 2015-2016 to 48% in 2018-2019 (EQAO, 2019).

The Programme for International Student Assessment (PISA) shares interesting data regarding the scores of students' achievement on standardized tests across the world in mathematics, language, and science. The most recent report stated that 23% of students in Japan were top performers in mathematics, compared to only 12% of students in Canada. These statistics identify quite a significant gap between the results for students within these countries, with 11% more students yielding higher scores in Japan (OECD, 2023). These results speak highly of the content and its delivery in each of these countries. However, while it does not fall within the scope of this study, it is important to note that cultural, social, and educational differences shape students' work ethics differently. As a result, the students' performance on tests is impacted by differences in academic responsibility, discipline, and attitudes toward learning.

This study holds significance due to the pivotal role of mathematics education in shaping the future success of individuals in society. Equipping students with the requisite knowledge and problem-solving skills during their formative years is essential for their transition into adulthood. This importance is further underscored by the recent COVID-19 pandemic and its profound impact on student mental health and academic performance, particularly in the field of mathematics. The widespread adoption of remote learning modalities has necessitated a significant proportion of students worldwide to engage in catch-up efforts, striving to bridge knowledge gaps accrued through online instruction (Chen et al., 2021). An intriguing international comparison emerges when contrasting the responses of Japan and Canada to the pandemic. While Japan managed to fully reopen its schools in the fall of 2020, schools in Canada and many parts of the United States opted for partially open, hybrid, or remote learning models (Chen et al.,

2021). Remarkably, Japan reported a shorter recovery period, with less than a month of learning loss, whereas Canadian schools reported over four months of lost learning upon reopening after prolonged closures (Chen et al., 2021). Thus, the significance of this study extends beyond its pedagogical implications; it serves as a poignant reminder of the resilience of educational systems and the paramount importance of robust educational principles amidst challenging circumstances like the COVID-19 pandemic.

While the framework of math textbooks does not solely account for Japan's resilience in the face of school closures, it serves as another example illustrating the potential benefits for Canadian schools to learn from international counterparts. Gaining a deeper understanding of the nature and structural framework of Japanese textbooks can significantly enhance the educational foundations in Canadian mathematics classrooms. Such insights can assist teachers in effectively addressing learning gaps and maintaining curriculum standards, thus facilitating the recovery of lost learning during the pandemic. Furthermore, the integration of sound pedagogy and textbook frameworks may serve as a protective measure against future learning losses in the event of school closures. By adopting and adapting teachings and practices from Japan, Canadian schools can fortify their educational approaches and better equip students for academic success amidst challenging circumstances.

Methodology

Mathematics is a complex subject for many students and teachers alike; ensuring students learn the required content in a way they understand is vital to their success. The current research is a comparative study of two textbooks. In order to provide a comprehensive comparison of the two textbooks, an overview of the layout and an in-depth review will be presented.

Topics and Layout

The comparison shows the Canadian textbook used in this study is Addison Wesley's "Math Makes Sense 5", published by Pearson in 2005 and it is updated regularly as the curriculum changes. It was written by a team of authors, including Peggy Morrow, Ralph Connelly, Bryn Keyes, and their many colleagues, and reviewed by a series of Ontario educators hailing from different school boards and regions. The textbook follows the Ontario Grade 5 math curriculum, spanning 11 units, each containing an average of 8.4 lessons (with a range of 5 to 14 lessons per unit). The textbook comprises of roughly 404 pages of content, games, unit reviews and problems, cumulative reviews, and cross-strand investigations. Each unit follows a similar pattern that begins with a "Launch", meant to probe student thinking and equip them with appropriate vocabulary and learning goals for the unit, followed by a series of lessons with special features such as World of Work (which showcases a related career) and Technology (which has students practice these skills through computer usage). Each unit ends with a Unit Review and Unit Problem. Each lesson is structured into 4 subsections: Explore, Show and Share, Connect, Practice, and Reflect. This format piques student interest at the beginning, summarizes the math concept, then allows students to practice and reflect on what they just learned.

The Japanese textbook used for this study is the Grade 5 National Mathematics Textbook, originally written and funded by Japan for schools across Papua New Guinea in 2020. This textbook is subdivided into 4 units with 15 major lesson topics, which are further subdivided into 2 to 4 smaller lessons in total. The textbook is half the size of the Canadian textbook, with only 213 pages. The textbook is written in a spiraling fashion, as each unit is intertwined throughout the book, switching between different major concepts and demonstrating how they are related, while also practicing previous concepts covered in the text. The lessons are structured by providing in-depth explanations and explicit instructions of the major math concepts, using visuals and exercises throughout the instructional portion of the lesson to engage student thinking. Each lesson concludes with an exercise portion that presents questions directly related to what was just taught. Finally, the "Problem" section consolidates conceptual understanding by integrating higher-order thinking questions, typically with real-world applications and examples.

Both textbooks cover the required material based on the curriculum they are following, yet there are some key differences to note between the two versions of the grade 5 textbook. Some of these differences include how each unit is outlined/covered, the order in which each topic is covered, and the amount of information broken down into each unit. The Ontario textbook covers all the required topics within eleven different units, with each unit broken down into multiple parts to cover everything a student in grade 5 should know by the end of the year. The Japanese textbook has 15 lessons that are smaller with changing orders. For example, the first lesson is on decimal numbers, while the second is on measurement. Indicating a significant difference in content presentation as the breakdown of the chapters differs. The Japanese textbook covers content quickly and concisely, spending some time on each topic before moving on to the next. The Ontario textbook takes longer to cover topics within large units before moving on to the next. As such, different textbooks reflect different curriculum interpretations, pedagogical intentions, and cultural or educational traditions. Consequently, this results in different conditions for students to learn mathematics depending on the way in which teachers use textbooks and present lessons (Van den Ham, 2018). The textbooks have some differences in content as they are from different areas with various cultures and educational traditions. Typically, the textbooks serve as guides for the teachers as the way they present the materials covered in the textbook will create different learning opportunities for the students who are learning within that classroom. An example of this can be shown in Ontario's second unit of the grade 5 math textbook, where the unit is whole numbers broken down into twenty lessons/sections. In comparison, the Japanese textbook's second unit is measurement, broken down into three lessons/sections. Throughout this textbook review and the placements within a math classroom, it is essential to note a problem regarding math itself within Ontario schools. Teachers within the classroom teach math based on their understanding and how it may best fit the classroom setting. However, a common occurrence in Ontario classrooms is math anxiety, which causes students to be less likely to enroll in and enjoy math courses, are less motivated to engaged in math tasks (McDonough & Ramirez, 2018). Math anxiety has been documented to be one of the most significant factors in students avoiding math-related educational tracks and careers (Ashcraft, 2002). Ashcraft & Ridley (2005) report that roughly 20% of students have high math anxiety. The content that is taught within the textbook is a link to this math anxiety, which is something that builds over time in multiple grades. This could be linked to the grouping of content within the math units, as the Ontario math textbook has large units that cover one

topic. In contrast, the Japanese textbook content is covered in smaller units, going from subject to subject. Therefore, the topics covered within both textbooks follow similar topics, but a differing delivery of the content presented. Changing the length of the units may help reduce the math anxiety that tends to affect the learning of Ontario math students. From a teaching perspective, the Japanese math textbook would be more engaging to the students within the classroom as the content is linked with countless examples of visual design to help students work through the problems and enhance their understanding and problem-solving skills.

Each book has its approach to how each lesson and chapter is laid out, especially how the content is presented. This includes various colours, headings, connections to real-world examples, and the overall makeup of each book page. A key difference between the two textbooks is the amount of information per page; the Japanese math textbook has less information per page with a larger font, making it easier to follow along while reading and preventing an overflow of information. Each lesson within this textbook begins with pictures, photos of real-life examples and colour-coded sections for easier understanding. Graphs and charts are commonly used for data representation, along with little graphics of characters to show the steps to take to complete the questions. Practice questions have pages beside them to refer to examples and steps for the questions. As for the world, problems themselves have a simplified explanation, along with their layout being on multiple pages rather than having all the questions squished onto a single page. The equations used for the topics are bolded and easy to read and understand. In this textbook, more open-ended questions and suggestions are offered by cartoonlike characters. The objective is to move away from providing clear explanations of concepts and procedures and to expect students to investigate mathematics using their reasoning based on their prior knowledge (Takahashi, 2016). This approach to learning is student-driven, meaning students are more likely to be engaged with the presented content. Using cartoonlike characters with more open-ended questions allows students to tackle the questions with reduced anxiety surrounding the mathematical content. The content within the Ontario textbook uses a closed approach to questions, making it less likely for students to connect to the material being presented within the classroom. This could be a factor for why Ontario students have more anxiety when it comes to mathematics. However, students in Japan can perform at higher levels than in Ontario because if students are not engaged with what they are being taught, they are less likely to pay attention to the lesson or be able to answer questions on the material in terms of using the textbook. On the other hand, the Ontario math textbook has more information per page, often with graphics or charts to represent the data the students will be using. Each unit within the textbook must explore, show, share, practice and connect questions or information to help answer the questions. The exploring part of the textbook focuses on an idea to work on with a partner, which one would then show and share the answers with other students. The practice and connect for this textbook give students practice questions and important tips to remember when working on the related content. The connected aspect of the textbook summarizes the math and gives students a chance to reflect on the lesson's content. Many math questions link back to real-world examples to have students understand why it is important to learn this type of math and potentially help avoid the why we must know this question within the classroom. The material that introduces students to the topic is provided in yellow step blocks, allowing students to follow along with the steps being taken for questions. At the end of each unit, there is a review section for students to practice everything they have learned. It can be used as test preparation to

ensure understanding or to check if there are concepts from this unit that may require a review prior to a test being given. Keywords and learning goals are also included within each unit in student-friendly language so they can refer to what they should be learning or understand the concept of complex math terminology better. This textbook also has a clear layout with limited information per page to ensure students understanding. As mentioned in the topics covered analysis, the units within this math textbook are broken into multiple lessons, meaning the time spent on the unit will be a larger time frame compared to the Japanese textbook, which has shorter units for each topic but changes from one to the next quickly. This way of presenting content can affect the student's achievement level. Study results indicate that there is a direct correlation between the amount of space allocated to covering a topic and the size of students' achievement gains on that topic (Van den Ham, 2018). Ontario students outperform most places in reading, but mathematically, Japan outperforms Ontario. Despite these studies, they have found a link between the time and space allocated for covering the topic. The Ontario math textbook has students working on the same topic for a longer time, while the Japanese textbook has shorter times for each topic but eventually goes back to cover more on the topic. This means spending a shorter time on each unit, but going back to the concepts more sporadically keeps students focused on the content and constantly refreshing themselves on concepts previously covered. While Ontario textbooks allow students time to focus on the material during each unit, once the unit is completed, it is not revisited, and it simply progresses to the next topic. Overall, in terms of material through content presentation, the Japanese textbook provides more student engagement in a clear student-led format. In contrast, the Ontario math textbook follows a closed approach to learning, with more time spent on each concept and a less engaging approach to learning math. For overall content presentation, the Japanese textbook surpasses the grade 5 Ontario math book regarding student-driven learning; however, from a teaching perspective, the Japanese textbook would be more complex for the teacher to teach within the classroom. As such, the benefits of this textbook would depend on how it is taught.

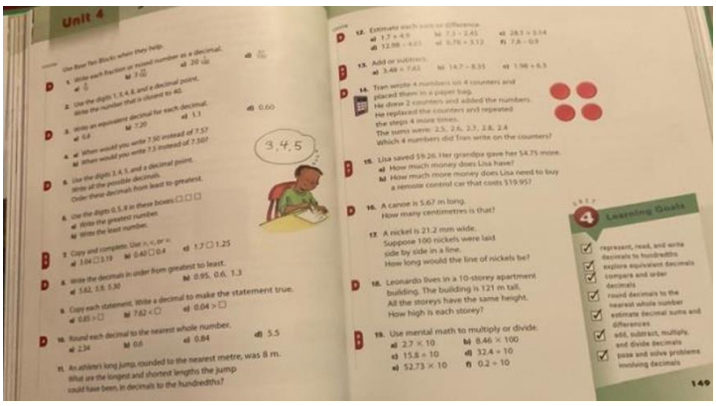
Through the exploration of the two Math textbooks, the elements of design within each book are very different. Elements for visual design are very similar to content presentation. However, there are still some key similarities and differences between both textbooks. Let us first look at the grade 5 Ontario textbook. The layout of the textbook follows a bold and easy-to-read format with multiple subheadings, so the reader has a clear understanding of what is being discussed. Photos, graphs, and charts present information in an easy-to-follow format, with the word problems connected to the visuals. Other vital things to note include the colouring coding. Subheadings are in purple boxes, step-by-step explanations are in yellow boxes, and each lesson is listed in red at the top. The colour coding makes the pages clear and allows students to quickly refer to when extra help is needed on a specific topic or to solve similar questions. This textbook also includes reflection questions written in a red book for extra practice on topics covered within each section. It is through the connection and engagement that students experience certain emotions that determine how they structure the process of learning the content in their brains (Kei, 2022). The Ontario mathematics textbook provides an excellent example of visuals and colour combinations that help engage young minds in learning. However, compared to the Japanese textbook, the Ontario book's overall visual design becomes less engaging as the Japanese textbook provides children-friendly visuals and not just real-life examples. This can be linked to the increased anxiety within Ontario's classrooms as the students are not creating this emotional connection when learning

mathematical concepts, linking the influx of students struggling with mathematical concepts. In terms of the Japanese math textbook, green textbooks are used for each unit's titles with visual aids and fill-in-the-blank questions for students to try. Questions within the textbook are linked to real-life examples. This includes some culturally based examples unique to the textbook. This textbook uses many colours to distinguish the various manipulatives used to explain or answer the question.

Along with graphics for manipulatives, this textbook also includes charts and graphs of data and various characters that provide hints or material to refer to in solving the questions listed. There is also a character who provides important ideas to solve the questions. A green crayon lists the exercises for this textbook, and the problem headings are large and bolded with colour. It is essential to have students engaged with the learning content, especially at a grade 5 level; more specifically, in order to meet the diverse visual needs of students, instructional content should be displayed in multiple different forms (Kei, 2022). This means having various characters, visual versions of manipulatives and a colour-coded content display. The Japanese mathematics textbook helps students by providing diverse content to fit the needs of various students using this textbook during their grade 5 mathematical education. Although cartoon characters in a textbook seem counterintuitive, this feature could benefit students. In contrast, others could find the colour coding or connections to real-life examples with visuals helpful in their connection to content and help keep students' interest in learning mathematical content. The flow of the textbook is bright and easy to follow with bold lettering and only the essential information required per page. Definitions for this textbook are listed in a sticky note format as phrases that define the words in student-friendly language. The visual makeup of this textbook provides an easy-to-follow approach to learning with some extra elements to keep students engaged with the material. For example, review the figures below of the decimal problems from each book.

Figure 1

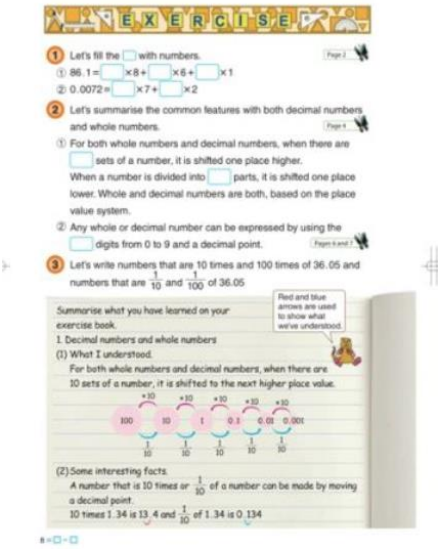
Taken from Pearson Math textbook



Note: This is from the Ontario math textbook the page is well spaced, but images are limited. The page itself has some visual aids to help students visualize questions along with no page numbers or references students can refer to help solve the questions.

Figure 2

Taken from National Math Textbook



Note: This is the exercise page from the Japanese math textbook at first look it has brighter colours, a summary of what the students learned and pages to refer to when completing the exercise if extra help is required. It also shows what the student should understand for completing the practice.

Overall, the Japanese textbook displays appear to be more appealing and eye catching to students, which is crucial to keeping them engaged with the material.

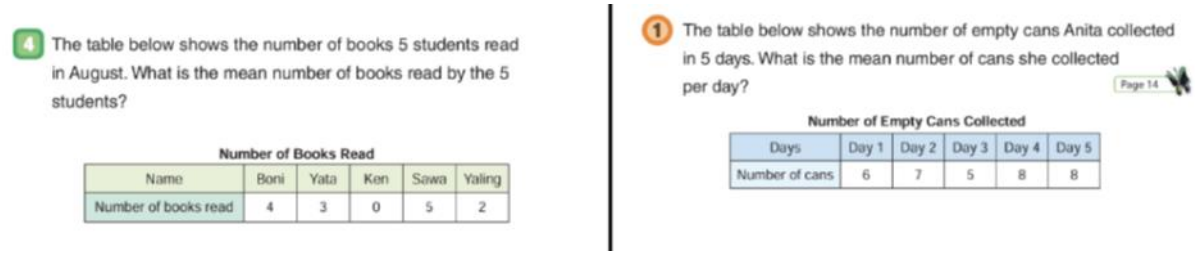
Rote Learning by Memorization

Mathematics is often perceived as a complex subject that can rely on multiple instructional approaches in the classroom. one of the most often discussed is rote memorization. Rote memorization refers to a style of learning done through repeated practice of the same procedural concepts (Manpreet, 2021). This stimulates memory and leads to quicker recall of facts and an efficient ability to recreate specific solving methods, although it lacks the fluency students require to apply their knowledge without procedural steps (Manpreet, 2021).

There is not one clear way to teach mathematics; however, how each country's textbook integrates such learning concept throughout their texts which may begin to explain the disparities between both Canada and Japan’s differing math scores. Figure 1 and 2 show examples of rote memorization (RM) questions found in both textbooks. These questions were considered RM if they directly mirror an example completed previously in the chapter. Thus, the student should be able to complete the question by simply mirroring the solving method laid out by the textbook.

Figure 3

Excerpts taken from the Japanese textbook



4 The table below shows the number of books 5 students read in August. What is the mean number of books read by the 5 students?

Number of Books Read

Name	Boni	Yata	Ken	Sawa	Yaling
Number of books read	4	3	0	5	2

1 The table below shows the number of empty cans Anita collected in 5 days. What is the mean number of cans she collected per day? Page 14

Number of Empty Cans Collected

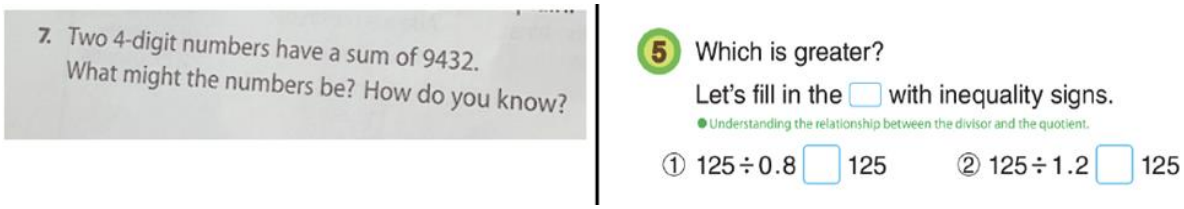
Days	Day 1	Day 2	Day 3	Day 4	Day 5
Number of cans	6	7	5	8	8

Note: On the left is an example of a question done during the 2nd lesson (p.14). On the right is a practice question that directly mirrors the same type of question, requiring the exact same solution method as the previous question (p.22). Thus, this is considered an RM question.

In addition to rote learning, both textbooks take into consideration aspects of deep student comprehension. Higher-order thinking (HoT) questions were evaluated based on whether the question required students to solve problems that cannot be solved by simply following previous examples. In these situations, students must use their knowledge to explain or solve more complex questions to build their understanding. Examples of these questions can be seen in Figure 4.

Figure 4

Questions taken from the Canadian and Japanese textbooks



7. Two 4-digit numbers have a sum of 9432. What might the numbers be? How do you know?

5 Which is greater?

Let's fill in the ☐ with inequality signs.

● Understanding the relationship between the divisor and the quotient.

① 125 ÷ 0.8 ☐ 125 ② 125 ÷ 1.2 ☐ 125

Note: The question on the left depicts a HoT question in the Canadian textbook where students must use their knowledge of 3 and 4-digit summation to create an expression that adds to a specific number and explain their process (p.36). The question on the right is from the Japanese textbook and asks students to use their knowledge of dividing decimals to determine if the resulting quotients will be larger or smaller than the dividend (p.71). In both of these texts, these questions cannot be solved by repeating specific steps laid out by the textbooks and probe students to use their knowledge of the concepts. Therefore, they are considered HoT examples.

Conceptual Understanding

Conceptual understanding of math concepts relies on more instructional strategies to demonstrate why specific math concepts exist and allows students to apply their understanding in a variety of contexts (Swing & Peterson, 1988). Students with a strong conceptual understanding of a concept create an interconnected understanding of it through different approaches including diagrams, real-world examples, formulas, and definitions and can demonstrate how these are all connected to each other (Swing & Peterson, 1988).

Characteristics of building conceptual understanding can be seen in examples of real-world application (RW) (Figure 5), visual representations (VR) (Figure 6), instances of spiraling (IS) (Figure 7), prompts for cooperation (CP) (Figure 8), manipulative usage (MU) (Figure 9), and showing alternative solving methods (AR) (Figure 10).

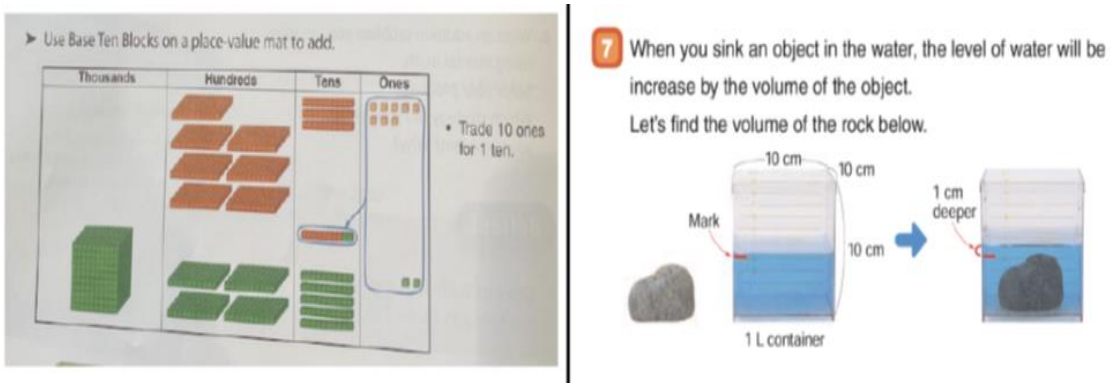
Figure 5

Questions taken from the Canadian and Japanese textbooks (RW)

Note: The question on the left depicts an example of a real world application of 4 digit addition using international architecture in the Canadian textbook (p.37). The question on the right relates to decimal numbers taken from the Japanese text and using a cultural element from Papua New Guinea (p.3).

Figure 6

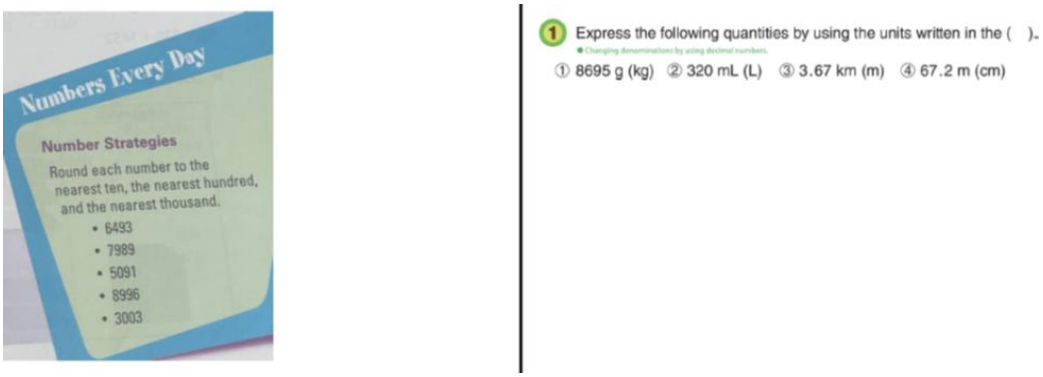
Questions taken from the Canadian and Japanese textbooks (VR)



Note: The question on the left is an example of a visual representation used in the Canadian textbook to develop a stronger student understanding of place values (p.34). On the right, this representation helps consolidate the abstract concept of volume in a visual way in the Japanese textbook (p.85).

Figure 7

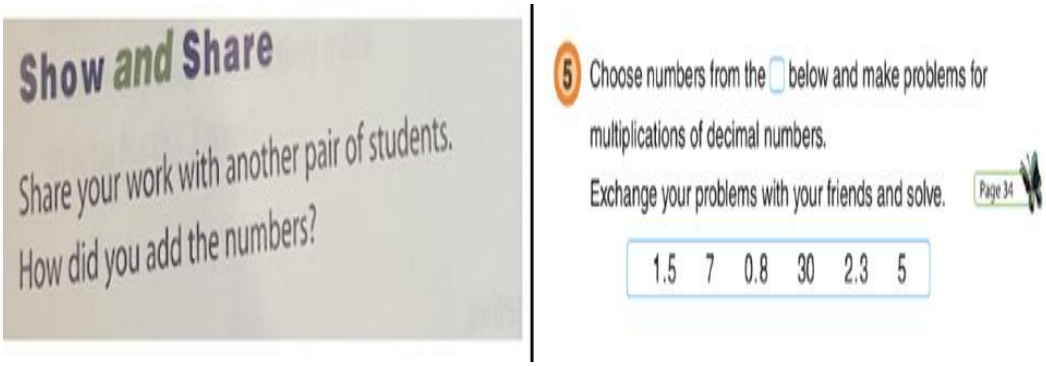
Questions taken from the Canadian and Japanese textbooks (IS)



Note: On the left is an example of the "Numbers Every Day" sections found throughout the Canadian textbook. These sections are meant to spiral and practice numeracy skills (p.33). On the right, is an example of a spiraling question found in the Japanese text. This specific question was found in the Decimals and Whole Numbers unit, yet is asking students to recall and use their knowledge of the measurement units to solve the problems, thus it is considered a spiraling question (p.9).

Figure 8

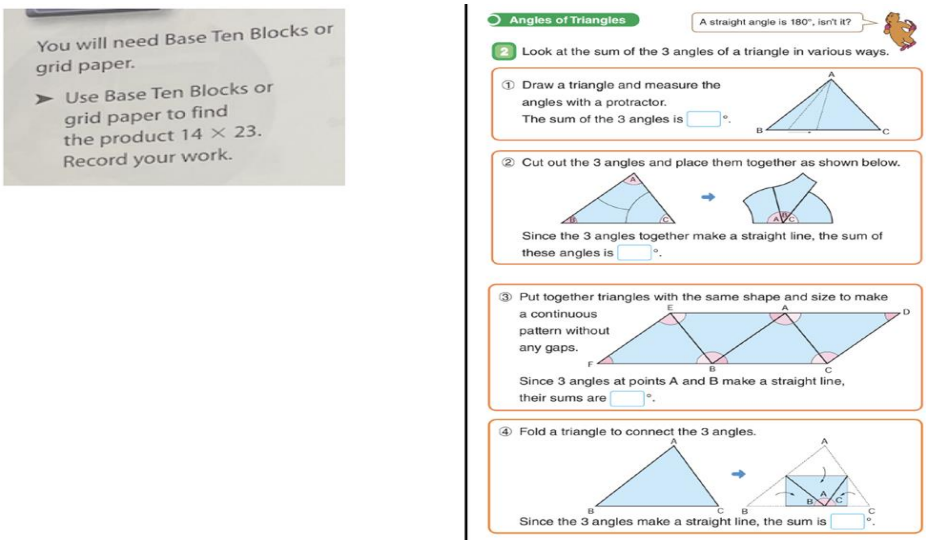
Questions taken from the Canadian and Japanese textbooks (CP)



Note: On the left is an example of a "Show and Share" prompt in the Canadian textbook, which are used throughout the text to encourage students to work together to solve problems and explain their solutions (p.37). On the right, is an example of a question in the Japanese text that asks students to work together, thus it is recorded as a cooperation prompt (p.35).

Figure 9

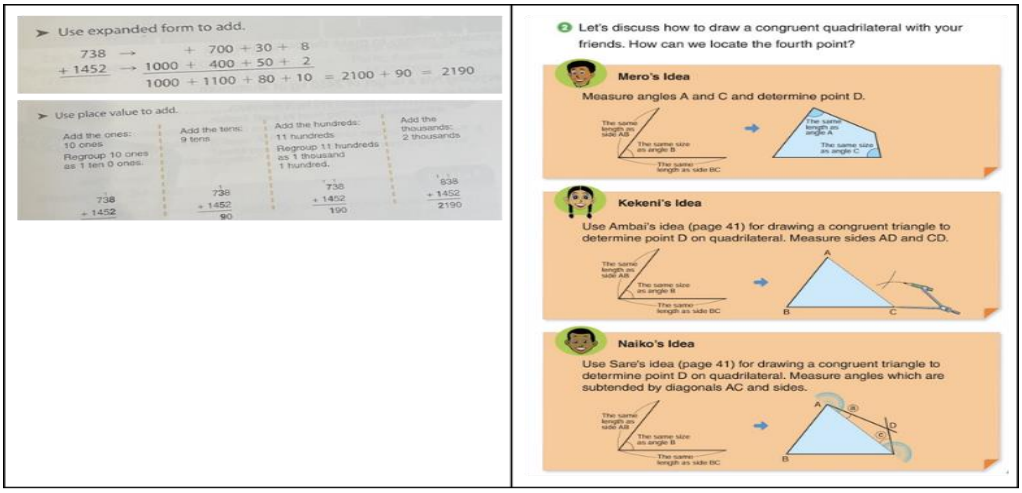
Questions taken from the Canadian and Japanese textbooks (MU)



Note: On the left, is an explicit example in the Canadian textbook asking students to use base ten blocks to find an answer to a complicated product question (p.58). On the right is another example of students being asked to use physical materials to consolidate and prove mathematical concepts in the Japanese textbook (p.49).

Figure 10

Questions taken from the Canadian and Japanese textbooks (AR)



Note: On the left, is an example of the Canadian text demonstrating different methods in which students may add 3 and 4 digit numbers (p.35). On the right is an example from the Japanese text that uses student characters to demonstrate different solving methods for students to relate to and follow (p.45).

Findings

Based on the comparison of the two textbooks, it appears that both textbooks cover the required content for a grade 5 student on the basis of the curriculum in the intended subject area. However, regarding topics covered and content presentation, the Japanese textbook provides a more engaging and, overall, more successful approach to teaching student's mathematical content. With student-driven differentiated instruction and open-ended questions, students can better engage with learning through an easy-to-follow textbook filled with extras to ensure students have the information they require to solve questions and understand examples. Elements of visual design once again predominate within the Japanese math textbook through the various characters, visual aids, and overall colour choice for the visual aspect of the textbook promote student engagement and help create positive emotions in mathematical content, which helps students create better learning relationships with the content being taught. Overall, based on the research found regarding the impact of students learning through the textbooks, the Japanese textbook has the advantage for student learning. However, from a teaching perspective, the Japanese open-ended student lead approach is more complex, which means if not properly taught, it could limit the success of the textbook and student learning. The Ontario textbook is still a comparable book, but making the textbook more engaging visually could improve students' overall performance when being taught with this book in the classroom. The comparison of the areas of understanding of the first 100 pages of each textbook revealed interesting results.

Table 1

First 100 Pages Textbook Comparison

Areas of Understanding	**Canadian Textbook**		**Japanese Textbook**	
	Number of Occurrences	**Percentage of 100 pages**	**Number of Occurrences**	**Percentage of 100 pages**
Rote Memorization (RM)	141	32.12%	88	23.10%
Conceptual Understanding	298	67.88%	293	76.90%
Higher Order Thinking (HT)	66	15.03%	62	16.27%
Real World Application (RW)	68	15.49%	61	16.01%
Visual Representation (VR)	59	13.44%	88	23.10%
Instances of Spiraling (IS)	24	5.47%	25	6.56%
Cooperation Prompt (CP)	30	6.83%	7	1.84%
Manipulative Usage (MU)	25	5.69%	23	6.04%
Alternative Solving Method (AM)	26	5.92%	27	7.09%
Totals	439	99.99%	381	100.01%

Note: Table 1 demonstrates the composition of the first 100 pages of each textbook in relation to the amount of rote memorization prompts to conceptual understanding elements. The topics covered in the Canadian textbook were units 1 through 3, including number patterns, whole numbers, and geometry. The Japanese textbook spirals its units; thus, the lessons covered in the first 100 pages included some content from the numbers and operations, measurement, and geometric figures units.

Table 2

Singular Lesson Comparison [Volume]

Areas of Understanding	**Canadian Textbook Lesson:**		**Japanese Textbook Lesson:**	
	Number of Occurrences	**Percentage of unit**	**Number of Occurrences**	**Percentage of unit**
Rote Memorization (RM)	2	13.33%	11	22.45%
Conceptual Understanding	13	86.67%	38	77.55%
Higher Order Thinking (HT)	4	26.67%	8	16.33%
Real World Application (RW)	0	0%	4	8.16%
Visual Representation (VR)	1	6.67%	14	28.57%
Instances of Spiraling (IS)	1	6.67%	1	2.04%
Cooperation Prompt (CP)	3	20%	1	2.04%
Manipulative Usage (MU)	3	20%	6	12.24%
Alternative Solving Method (AM)	1	6.67%	4	8.16%
Totals	15	100.01%	49	99.99%

Note: Table 2 provides a singular lesson comparison in which both texts taught the same subject: volume. The Canadian textbook's volume lesson spanned 3 pages, while the Japanese textbook used 14 pages to fully explain and exemplify volume. This specific comparison aids in comprehending the major differences between the texts and their educational approaches in teaching new concepts.

The major differences between the textbooks were witnessed among the rote memorization categories and conceptual understanding elements, including visual representations, cooperation prompts, and real-world examples. In the 100-page analysis, the Canadian textbook had 9.02% more rote memorization questions compared to the Japanese textbook. The discrepancies among the conceptual understanding also differed greatly; the Japanese textbook had 9.66% more instances of visual representations, 1.17% more alternative solving methods, and 1.09% more instances of spiraling throughout the first 100 pages. The Canadian textbook, instead, had 4.99% more instances of student cooperation work and questions. Overall, the ratio of rote memorization questions to higher-order thinking questions

was 2.14:1 for the Canadian text and 1.42:1 for the Japanese textbook. Thus, the Japanese text had a much more equal relation between the amount of questions that both build conceptual understanding and hone explicitly taught methodology.

This variance between the content covered may affect the abundance of conceptual understanding elements. Therefore, a singular lesson on the same topic, volume, was analyzed. This lesson analysis showed some variance with respect to the same categories analyzed previously. Throughout the lesson, the composition of the Japanese textbook had instances of rote memorization questions more than the Canadian textbook by 9.12%. The Japanese textbook also had 21.9% more visual representations, 1.49% more alternative solving procedures, and 8.16% more real-world applications. The Canadian textbook, instead, had a higher composition of higher-order thinking questions (10.34%), manipulative usage (7.76%), spiraling (4.63%) and friend cooperation prompts (17.96%). The ratio of rote memorization questions to higher-order thinking also differed from the 100-page comparison, as the Canadian text had 1:2 and the Japanese text had 1.375:1. Thus, the Canadian textbook used more instances of higher-order thinking than the Japanese text when comparing the volume lesson.

Discussion and Conclusion

The analysis results showed some relationships among the number of instances in which each text used rote memorization or conceptual understanding prompts throughout their textbook units. The first 100-page analysis showed the Canadian textbook using more questions requiring rote memorization than the Japanese textbook. However, the lesson comparison showed the opposite, with the Japanese textbook having more instances of rote memorization. This demonstrates how the topics and curriculum covered throughout the text have an effect on the type of questions being asked in the texts. This is also not to say that the use of rote memorization is a negative attribute of the texts.

Practicing mathematical procedures is a necessary skill to foster student fluency (Foster, 2018); thus, the textbooks incorporating these types of questions are a beneficial addition to the units. The variance in the percentage of questions considered as "rote memorization" indicates how these questions are not an area of concern, as each text varies between 13% to 32% being composed of RM tasks. Thus, the focus of this analysis will be on how each text decided to teach conceptual understanding to their students.

The largest deficits between the texts were in the categories of visual representations, cooperation prompts, and alternative solution methods. Overall, the Japanese text used an abundance of visual representations to help support student learning and understanding of the content. This difference between the texts implies that the incorporation of visual graphics, definitions, and diagrams may enhance students' comprehension and increase math skills.

The Japanese textbook also incorporated more alternative solving methods for the same problem compared to the Canadian text. Demonstrating various solution methods can help support student understanding, offer options for

choice, and help them understand where the solutions are coming from. The Canadian textbook, on the other hand, has more cooperation prompts for student learning. This relationship may signify that the need for students to collaborate and learn together may not be as vital to building conceptual knowledge as the other categories, as they are not as emphasized in the Japanese text.

Another area of interest is the instances of spiraling throughout both texts. They had similar instances of spiraling; however, the content being reviewed varied significantly. The Japanese textbook was built upon spiraling as the very construction of the text spiraled between lessons in the curriculum. Compared to the Canadian text, in which each unit had a clear beginning, middle, and end. The instances of spiraling in the Japanese text flowed smoothly as they integrated core concepts of different units into other units, consolidated, and practiced previous connections they made. The Canadian textbook's instances of spiraling only occurred in the section "Numbers Every Day" (Figure 6), where students practiced different number operations to help their mental math skills. This difference in the application of spiraling in the text is worthy of noting and should be further studied in future analyses.

Another interesting note made was the lack of real-world connections made in the volume lesson in the Canadian textbook. Volume can be a difficult concept to grasp, and the Canadian text chose not to incorporate real-world connections, which may render the concept more abstract and harder to grasp. This is especially relevant as studies show that building connections in mathematics is correlated with the depth and quality of students' mathematical understanding (National Research Council, 2001). This relationship between real-world connections should also be further developed to better understand how this may affect student conceptual understanding.

Following an in-depth review of the Japanese textbook's content, it can be concluded that it excels at teaching mathematical content due to its student-friendly language, high level of engagement, and ability to create positive emotional responses in the classroomThe overall layouts of the books affect how effective they are in teaching mathematical topics and the content students can understand. Thus, the topics covered, content presentation and visual design elements can make or break student engagement and learning regarding these textbooks. An important note is that textbooks are just a basis for learning, and the effectiveness of the textbook is highly impacted by teaching practices within the classroom and students' emotional and physical engagement with the content.

Limitations

There are some limitations to the study. One limitation is that neither the entire textbooks nor an individual lesson comparison where both texts taught the same subject could be done because the research paper was limited in length. Rather, only the first 100 pages of each textbook and one lesson within the same topic were used to gauge the results. The second limitation of the study is that it was not an experimental study, but rather a correlational study that analyzed existing data. Although this study acknowledges that teacher and teacher pedagogy may interact with textbooks and student learning, it examined only how textbooks provide opportunity for students to learn. Another limitation of this

study is that it only analyzed the percentages of the different areas of understanding in each textbook. The textbooks may have contributed to variations in students' performance in other ways.

Implications

The implications of this study extend beyond textbook authors and classroom teachers to encompass education stakeholders and officials in Ontario. Numeracy and mathematics education have long been focal points of contention among education stakeholders and officials, who have continuously adjusted the structure and assessments of education in pursuit of a better understanding of student numeracy deficits and how teachers can better support these students (Boyd, 2021). Over the past 30 years, education funding has been allocated to various strategies aimed at standardized tracking and creating an environment conducive to progress and success (Boyd, 2021). Therefore, one avenue through which policymakers and the Ministry of Education can further pave the road to success is by learning from others. Japan's educational philosophy and structure have demonstrated resilience in the face of adversity, consistently yielding above-average comprehension scores on international tests and producing expert math students. It seems only natural that these funds and policies leverage differences in educational approaches to support Canadian learners and Ontario classroom teachers in their ongoing pursuit of student success.

The implications also extend to the future of educational studies in Ontario, providing a foundation for researchers to build upon. This study serves as a stepping stone for future educational research in Ontario by offering a clear direction for further exploration. Currently, there is a lack of recent comparative analysis contrasting Ontario's numeracy pedagogy and instruction with that of other countries (Perlazal & Tardif, 2016; Tatto, 2023). However, the potential insights from international schools are invaluable, particularly as Ontario experiences increasing immigration and classrooms become more diverse, requiring additional support for students transitioning into the Canadian workforce (Nichols et al., 2020). Consequently, this study not only propels future educational research but also has the potential to inform pedagogical support for Canadian teachers assisting learners from high-achieving international backgrounds. By integrating and analyzing Japan's textbook framework, we can better support future math learners in Ontario and continue to emphasize the importance of learning from our peers and other countries' successes. Ultimately, in education, there are no winners or losers; rather, our collective goal is to ensure the best outcomes for all students.

There are multiple aspects that should be considered and further researched to support its findings that this analysis lacked. Firstly, the definitions and breakdown of conceptual knowledge should be called into question, as this analysis used broad examples that may not have fully encapsulated all elements present in the textbooks. For example, although each text had similar proportions of spiraling, they approached spiraling in very different manners.

Additionally, it is worth noting that the broad nature of this analysis may have overshadowed other, more pressing, categories. If this analysis were to be repeated, only the categories with significant differences should be further analyzed to better understand why these differences exist and if they correlate with student success in mathematics.

Another area of concern is the pages studied and the differing curriculum. To better understand why there are major differences between the first 100 pages and the singular lesson analysis, future studies should analyze the entire textbook and compare more individual lessons to determine where and why the variance exists in different conceptual understanding categories. Math comprehension is of utmost importance as it is not only embedded in the workforce but also serves as an early predictor of later academic achievement (Stokke, 2015; Braak et al., 2022). It is therefore of significant value internationally since mathematics continues to be highly regarded in classrooms worldwide because of a strong association between early mathematical proficiency and later academic achievement in learners (Braak et al., 2022). This is particularly relevant in Ontario classrooms, where fewer students have been able to achieve or exceed provincial standards in recent years (Stokke, 2015). Ontario educators should continue to collaborate and learn from teachers internationally to integrate and adapt different instructional strategies and teaching methods into their classrooms. This not only enhances diversity within one's own instruction and classroom organization but also fosters continuous learning and growth among current and upcoming educators.

Some studies have found that teachers using different types of math textbooks use different teaching strategies, and textbooks can convey pedagogical messages and encourage or discourage teachers to use certain teaching strategies (Fan & Kaeley, 2000; Fan et al., 2021). As a result of this study, we gain a better understanding of the similarities and differences between Ontario and Japan in terms of teaching mathematics and pose two questions for future research. What impact might these differences have on students' learning? Could the design elements influence the effectiveness of the textbook for teaching and learning? It is anticipated that these questions will lead to more textbook research in other areas that might impact the way mathematics is taught and learned.

Education is an ever-evolving field, with millions of children relying on it to prepare them for the future and set them up for success. It is imperative that we create systems and support for mathematics educators in Ontario. Learning from others is a great way to begin addressing our decreasing math scores and supporting students who are eager to learn and succeed.

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