SNAP vs. FSA: Competency-Based Numeracy Assessments Count

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SNAP vs. FSA: Competency-Based Numeracy Assessments Count

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Abstract

This study examined the predictive qualities of a competency-based mathematics assessment relating to a traditional mathematics assessment. The competency-based assessment is a school district developed assessment called the Student Numeracy Assessment & Practice (SNAP). The traditional mathematics assessment is the Foundation Skills Assessment (FSA), developed and provincially mandated by the British Columbia Ministry of Education. The study's methodology examines the correlations between student achievement on SNAP and the FSA. The study controls for social economic status (SES), ethnicity, special education designation, and gender in the context of middle school learning in Chilliwack, British Columbia and answers the question: Does student achievement on the grade 6 SNAP predict achievement on the grade 7 numeracy FSA? Additional research questions consider the impact of independent variables (reading achievement, report card mathematics achievement, and mathematical student self-efficacy) on both the FSA and SNAP assessments.

This study's methodological approach involved the correlation of student cohort achievement data limited to the 2018/19 cohort of year six (grade 6) students in the Chilliwack School District. The study followed this cohort's achievement through completing the grade 7 FSA in the fall of 2019. There are 786 students represented in the sample size.

The study showed a strong correlation r = .60 between SNAP and FSA. Additional findings included similar correlations between both assessments and classroom-based letter grades. Final findings included a strong correlation between FSA numeracy achievement and FSA reading achievement. Remarkably, this correlation was not evident between SNAP and FSA reading, indicating a striking difference between the two assessments. Identifying a competency-based numeracy assessment that does not have significant correlation to reading achievement is the most significant outcome of this study.

Keywords: FSA, SNAP, ANIE, Numeracy Assessment, For, As and Of Learning, competency-based mathematics, reading

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This research paper has been a long time in the making. Since the inception of ANIE in 2005 – the journey towards numeracy assessment excellence has not been one I have walked alone. From day one, my friend and colleague Kevin Bird has been there as we have pushed each other's thinking while collaborating on so many projects. This paper represents another important step in the ongoing quest.

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Thank you to Dr. Yong Zhao and Chris Kennedy who had the vision to create a British Columbia based doctoral program for BC leaders – I feel so lucky to have learned alongside so many fantastic and local educational leaders.

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CHAPTER ONE

Introduction

In 2016 mathematics curriculum in British Columbia shifted to a competency-based format from a content-driven approach (Sanford & Hopper, 2019), but testing practices have yet to align. The purpose of this study is to examine the predictive qualities of a competency-based mathematics assessment in relation to a traditional mathematics assessment. The competency-based assessment is named Student Numeracy Assessment & Practice (SNAP), a mathematics assessment developed in Chilliwack, British Columbia. The traditional mathematics assessment is the Foundation Skills Assessment (FSA), a provincial mathematics assessment created by the BC Ministry of Education. The study's methodology examined the correlations between student achievement on SNAP and the Foundation Skills Assessment (FSA) while triangulating for reading achievement, mathematics letter grades and student perception of math efficacy.

An important premise of this study is that student assessments have three main functions for educators (Stiggins, 2002, 2014):

1. As a formative assessment – for learning
2. As a summative assessment – of learning
3. As a learning experience – as learning

These three functions are explored further throughout the paper, but for now, it is enough to state that FSA is primarily a summative assessment, and SNAP appears to do all three.

This chapter begins with a description of the study's purpose and then provides context and background for the reader. The research question and an overview of the methodological approaches are also presented before wrapping up the chapter's big ideas in the conclusion.

Purpose of the Study

Dr. Rick Stiggins (2017), an educational assessment expert with a doctorate from Michigan State University, asks this question, "What if we reversed our priorities and used assessment to support teaching and learning first and foremost while still managing to satisfy our accountability needs" (p. 6)? This reversal of priorities, while at the same time providing accountability measures, is the driver of this study. Can a school district's experience with SNAP supply a blueprint for the province to shift to prioritizing assessment that works for classroom teachers?

This study's big idea is to uncover evidence that might elevate competency-based assessments in the minds of educational decision-makers by showing that the former (research-based classroom assessments) are related to the latter (accountability measures). These decision-makers include classroom teachers (who decide how they teach), administrators (who make schoolwide decisions), and politicians (who impact policy decisions). By describing the research that underpins an example of a competency-based assessment (SNAP), comparing achievement results to an existing accepted assessment, and triangulating these assessments with reading achievement, math letter grades, and student perception of math efficacy, the hypothesis is that assessment approaches such as SNAP might become widely adopted with increased acceptance.

Context

The study took place in Chilliwack, a city of approximately 90 thousand people located 100 kilometers outside Vancouver, the largest city in British Columbia. The school district enrolls 14 thousand students from Kindergarten to Grade 12 (K-12). The researcher is a member of the district's senior leadership team and is a co-creator of the Student Numeracy and Practice (SNAP) assessment. The SNAP was implemented in 2016 for students in grades 2-7, and the school district use continues presently. The study used data from all five middle schools in

Chilliwack, with a combined enrollment of 1000 students. Two of the middle schools are in the 'inner city' of Chilliwack. These schools have lower socio-economic status based on postal code and higher special education populations. Two schools are in relatively affluent urbanized neighborhoods, and the final school is in a rural setting.

Background of SNAP and FSA

Competency-based mathematics assessments require students to show an understanding beyond the rote learning found in classrooms where teachers employ a 'drill and practice' teaching approach. Using a competency-based assessment, educators have a way to understand how students think their way through their mathematics skills and knowledge acquisition. A competency-based curriculum is student-focused, and there is flexibility in time and space for students to show their learning (Twyman, 2014). The big idea behind competency-based assessment use is that the assessment directly impacts what the teacher does next in their classroom.

The current (as of 2016) British Columbia curriculum organizes mathematics competencies into four areas: reasoning and analyzing, understanding and solving, communicating and representing, and finally, connecting and reflecting. These competencies are designed to combine with the curriculum's content areas to provide teacher direction as they create learning standards.

In 1998, the British Columbia Ministry of Education created Performance Standards in Literacy and Numeracy (see Figure 1.1) to provide educators with a new way to inform assessment practices. These Performance Standards were rubrics that helped teachers focus on thinking skills and strategies that students could show when doing tasks instead of using traditional right/wrong questions and answers. The Performance Standards were a precursor of what was to come with the redesigned curriculum in 2016, and there are recommendations in place "to refresh and add to existing performance standards to reflect changes to the curriculum" (Stanford & Hopper, 2019, p. 96).

Figure 1.1 Numeracy Performance Standards (BC Ministry of Ed, 1998)

Quick Scale: Grade 7 Numeracy

This Quick Scale is a summary of the criteria described in detail in the Rating Scale that follows. These criteria may apply at any time of the year, depending on when specific skills or concepts are introduced.

Aspect	Not Yet Within Expectations	Meets Expectations (Minimal Level)	Fully Meets Expectations	Exceeds Expectations
SNAPSHOT *Note: the snapshot can be used alone as a holistic scale for marking some assignments.*	***The work is insufficient. The student is unable to meet basic requirements of the task without close, ongoing assistance. No relevant extension.***	***The work satisfies most basic requirements but is flawed or incomplete. The student may provide an extension that varies slightly from the original task.***	***The work satisfies basic requirements of the task. If asked, the student can produce a relevant extension or illustration.***	***The work is complete, accurate, insightful, and efficient. The student may volunteer an extension, application, or further illustration of the same mathematical idea.***
CONCEPTS AND APPLICATIONS* • recognizing mathematics • grade-specific concepts, skills • patterns, relationships	• unable to identify concepts or procedures needed • does not apply relevant concepts, skills, and strategies appropriately; major errors or omissions • unable to recognize patterns and relationships	• identifies most concepts and procedures needed; may oversimplify • applies most relevant concepts, skills, and strategies appropriately; some key flaws • with support, can recognize and use some patterns and relationships	• identifies concepts and procedures needed • applies relevant concepts, skills, and strategies appropriately; may be somewhat inefficient • recognizes and uses basic patterns and relationships	• identifies concepts and procedures needed; may offer alternative methods • applies relevant concepts, skills, and strategies accurately and efficiently; thorough • recognizes and uses patterns and relationships; generalizes
STRATEGIES AND APPROACHES • analyze problems • procedures • estimate to verify solutions	• unable to analyze problems • unsystematic and inefficient; unable to follow appropriate strategies • answers or solutions are often improbable (weak estimation skills)	• analyzes problems to develop a plan • follows instructions without adjusting procedures; inefficient • may need reminding to verify results or solutions; estimates are generally logical	• analyzes problems to develop a plan • structures the task into logical steps or stages; may be inefficient • makes logical estimations to verify results or solutions	• analyzes problems to develop an efficient plan; insightful • structures the task efficiently; may find alternative methods • makes relatively accurate estimations to verify results or solutions
ACCURACY • recording • calculations • charts, diagrams, graphs	• recording is frequently inaccurate • major calculation errors • major errors in charts, diagrams, and graphs	• some recording errors • some calculation errors, often involving decimals • some errors in charts, diagrams, and graphs	• minor recording errors • minor errors in calculations • minor errors in charts, diagrams, and graphs	• accurate and precise records • accurate calculations; may use mental math • charts, diagrams, and graphs are accurate and precise
REPRESENTATION AND COMMUNICATION • presenting work • constructing tables, charts, diagrams, displays • demonstrating procedures, explaining results	• work is often confusing, with key omissions • often omits required charts, diagrams, and graphs or makes inappropriate choices • explanations are incomplete or illogical; little or no mathematical language	• most work is clear; may omit some information • creates required charts, diagrams, and graphs; some features may be incomplete or inappropriate • explanations are incomplete; little mathematical language	• work is generally clear and easy to follow • creates required charts, diagrams, and graphs appropriately; minor omissions • explanations and demonstrations are complete, in own words, and include some mathematical language	• work is clear, detailed, and well-organized • creates effective charts, diagrams, and graphs • explanations and demonstrations are clear, in own words, and include mathematical language; may be innovative or insightful

* *You may want to list key curriculum concepts or skills for a particular task.*

As a teacher in 1999, I noticed that my colleagues who taught Language Arts readily implemented the Performance Standards in classrooms, while my mathematics teacher colleagues did not use the Numeracy Performance Standards. Mathematics teachers struggled to understand how to change their teaching to align with mathematical competencies and thinking. Examples of these competencies from 1999 include the 'Aspect' column from Figure 1.1 of the Numeracy Performance Standards. Teaching for concepts, application, strategies, and approaches was not something that I did naturally when I first started teaching mathematics.

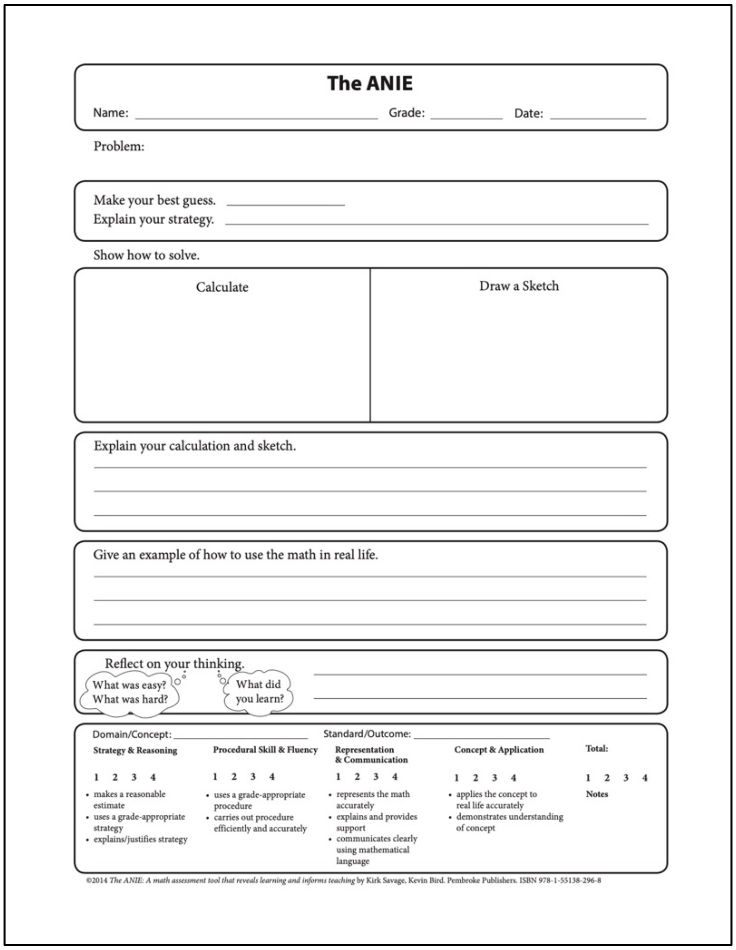
Surrtamm et al. (2016) suggest that the slow move to teaching and assessing for student understanding was not novel to my practice or teachers in my school.

> The current vision of mathematics instruction requires an ongoing assessment that provides evidence for student understanding to inform instruction. However, as Swan and Burkhardt (2012) note in their discussion of assessment design and as noted by other researchers in assessment (e.g., Black et al. 2004), change is not easy or swift (Suurtamm et al., 2016).

In 2005, I took a particular interest in Mathematics Performance Standards' potential and co-created a mathematics assessment that aligned with the Provincial rubric. We named it the ANIE (Assessment of Numeracy in Education), shown in Figure 1.2.

Utilizing the Numeracy Performance Standards as the evaluation rubric, the ANIE was the first competency-based numeracy assessment in British Columbia. For the first time in over seven years, I collaborated with teachers who dusted off the Ministry of Education documents and used them in classrooms. In 2014, Pembroke Publishers formally published The ANIE (Bird & Savage, 2014). In 2012, I found myself in the Director of Instruction role in the Chilliwack School District, where we used the foundational underpinnings of ANIE to create a district mathematics assessment for students in grades two through seven. We named the new mathematics assessment SNAP, an acronym for Student Numeracy Assessment and Practice (Chilliwack School District, 2016). The SNAP has been the school district's formal mathematics assessment since 2016.

Figure 1.2 The ANIE



The ANIE

Name: ____________ Grade: ________ Date: ________

Problem:

Make your best guess. ________
Explain your strategy. ________

Show how to solve.

Calculate	Draw a Sketch

Explain your calculation and sketch.

Give an example of how to use the math in real life.

Reflect on your thinking.

What was easy? What was hard?

What did you learn?

Domain/Concept: ________ Standard/Outcome: ________

Strategy & Reasoning	Procedural Skill & Fluency	Representation & Communication	Concept & Application	Total:
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
• makes a reasonable estimate • uses a grade-appropriate strategy • explains/justifies strategy	• uses a grade-appropriate procedure • carries out procedure efficiently and accurately	• represents the math accurately • explains and provides support • communicates clearly using mathematical language	• applies the concept to real life accurately • demonstrates understanding of concept	Notes

The Chilliwack school district supported the SNAP initiative with staffing and funding. The District hired two helping teachers and several relief teachers to train all classroom teachers in grades two through seven in the new assessment. The District followed up with more training in year two to interpret the results and plan for instruction. In the third and fourth year of implementation, Chilliwack's classroom teachers learned high yield mathematics strategies through district in-service opportunities. This in-service focused on how teachers could intervene with student gaps in learning – based on student SNAP results. Evidence of this success is anecdotal, but most teachers believe a shift occurred in the District's mathematics culture.

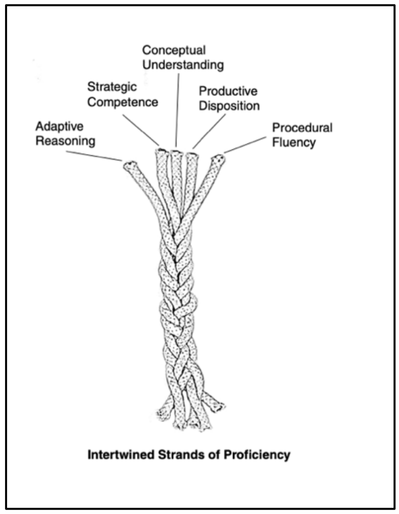
There are currently seven BC school districts that have adopted the SNAP. Three of these districts have worked with Chilliwack to ensure personalized access to the SNAP website

(Chilliwack School District, 2016). Additional indications that the culture of teaching mathematics is improving throughout the District include multiple visitations to Chilliwack from educators from BC, Illinois, Quebec, and Australia. These visitors came to Chilliwack to learn about the District's approach to mathematics assessment. The Social Media platform Twitter, under the hashtag *#sd33learns* and *#mathSNAP33,* shows a celebration and recognition of mathematics instruction in Chilliwack that before SNAP implementation was near non-existent. The SNAP implementation has given the school district an opportunity to spend time and resources on numeracy, resulting in anecdotal improved teacher perceptions of teaching mathematics. However, what is not clear is whether the perceived improvements in mathematics culture are centered on a valid assessment or simply an assessment that many teachers like to use. To help answer this question of validity, the researcher proposes standing up the SNAP assessment against the established provincial numeracy assessment – the Foundation Skills Assessment (FSA).

What is the SNAP?

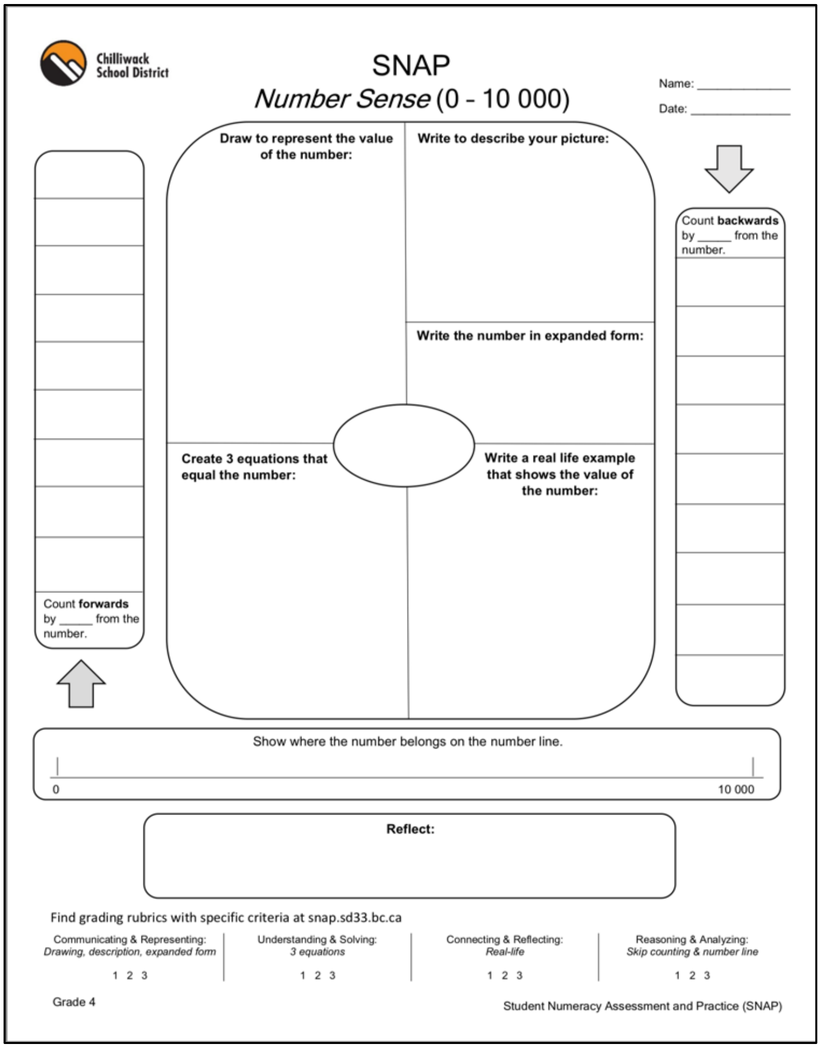
SNAP is a competency-based, one-page mathematics assessment and practice tool. The one-page templates and rubrics claim to be simple, straightforward and provide a clear snapshot of learning evidence (Chilliwack School District, 2016). Practical and authentic 21st-century assessment extends beyond gathering data on paper, however. SNAP creators intended the assessment to inform the rest of the learning process and drive the purposeful, responsive action needed to guide students down the path to mathematical proficiency (Chilliwack School District, 2016). Mathematical proficiency, as defined by Kilpatrick, Swafford, and Findell (2001), "captures what we think it means for anyone to learn mathematics successfully” (p.5). Additionally, Kilpatrick, Swaffold & Findell break down mathematical proficiency into five strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. They see these strands as interwoven and interdependent. See Figure 1.3 for a visual example.

Figure 1.3 Strands of Proficiency (Kilpatrick, Swaffold, & Findell, 2001)



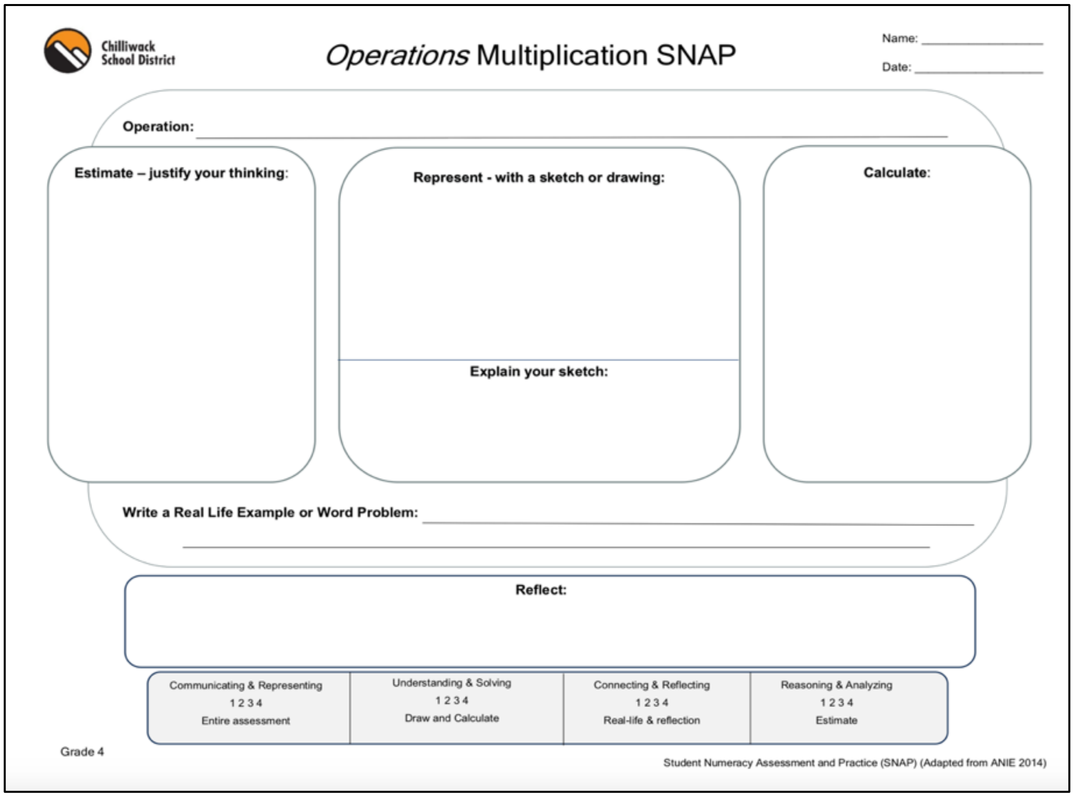
The SNAP is an acronym and stands for "Student Numeracy Assessment & Practice" (Chilliwack School District, 2016). The term *practice* is a crucial aspect of the assessment. It supports a spiraled approach called "interleaving" to teaching and assessing numeracy skills (Rohrer et al., 2015). The SNAP is an assessment that teachers can repeatedly use to build student fluency, confidence, comprehension, and skills. It can be used as a formative assessment to inform instructional practices and a summative assessment to report on student achievement. The formal spring SNAP assessment is intended for summative reporting purposes, whereas SNAP's regular ongoing use (practice) is intended for formative use. The SNAP has its philosophic underpinning based in The ANIE, published by Pembroke Publishers. SNAP and ANIE's key difference is that SNAP focuses on two main mathematical strands – Number Sense (Figure 1.4) and Operations (Figure 1.5). The ANIE is designed for teachers to assess any mathematical concept (Bird & Savage, 2014).

Figure 1.4 The Number Sense SNAP



SNAP focuses on two foundational content areas only (Number Sense and Operations). The District SNAP Working Group (consisting of ten educators) believed that a competency-based curricular focus on two foundational outcomes would be sufficient to nudge teacher practice and improve student results (Chilliwack School District, 2016). Ideally, teachers use SNAP to assess and teach a wide variety of mathematics outcomes; and the District limited the formal district assessment outcomes to ensure that the District data collection did not overwhelm classroom teachers. The present study is designed to determine how SNAP correlates to the more standard mathematics measurement used by the district (FSA).

Figure 1.5 The Operations SNAP



Chilliwack School District

Operations Multiplication SNAP

Name: _______________

Date: _______________

Operation: ______________________________

Estimate – justify your thinking:

Represent - with a sketch or drawing:

Explain your sketch:

Calculate:

Write a Real Life Example or Word Problem: ______________________________

Reflect:

Communicating & Representing 1 2 3 4 Entire assessment	Understanding & Solving 1 2 3 4 Draw and Calculate	Connecting & Reflecting 1 2 3 4 Real-life & reflection	Reasoning & Analyzing 1 2 3 4 Estimate

Grade 4

Student Numeracy Assessment and Practice (SNAP) (Adapted from ANIE 2014)

What is the FSA?

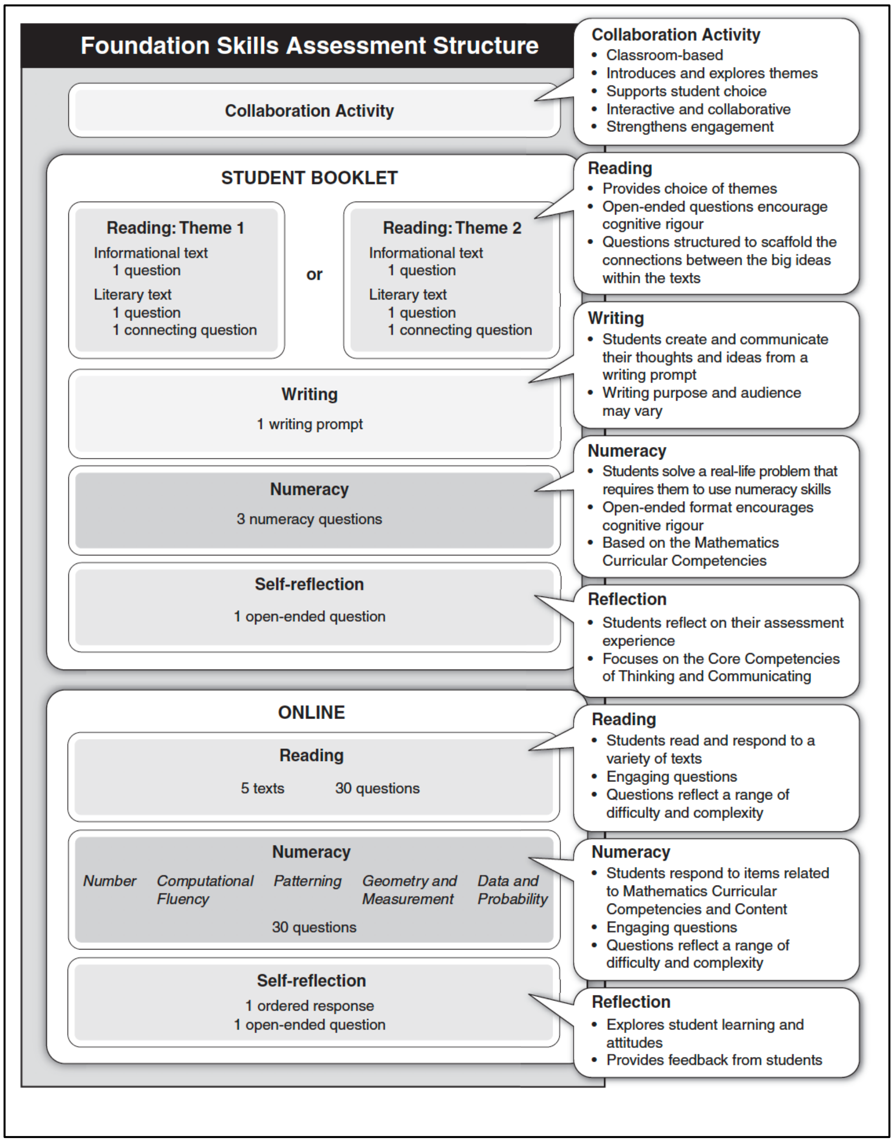
British Columbia's Ministry of Education creates and conducts a yearly assessment (since 2000) for all grade 4 and grade 7 students in literacy and numeracy called the FSA (Foundational Skills Assessment). Students complete this assessment in the fall with a portion of the assessment done online and a portion handwritten (BC Ministry of Education, n.d.). The entire assessment takes about three to four hours for students to complete. The Ministry of Education website describes the FSA in these words:

> The Foundation Skills Assessment is an annual province-wide assessment of all B.C. students' academic skills in grades 4 and 7. It provides parents, teachers, schools, school districts, and the Ministry of Education with important information on how well students

are progressing in the foundation skills of Reading, Writing, and Numeracy. (BC Ministry of Education)

Figure 1.6 (below) provides an overview of the entire FSA assessment structure, as per the Ministry of Education.

Figure 1.6 FSA Structure



The FSA has received mixed reviews in the educational community. The British Columbia Teachers Association (BCTF) has been a long-time opponent of the assessment, citing that it takes too long, is not connected enough to curriculum, and that private organizations misuse the results to rank schools (BCTF, 2021). Meanwhile, the Ministry of Education continues to promote FSA use to ensure system accountability in the K-12 education sector. Each year, a team of seconded educators working above and beyond their regular school and district jobs creates the FSA. They complete this extra work under the direction of the Ministry of Education staff. The present study is designed to determine the extent to which SNAP correlates to the FSA.

Research Questions

The purpose of this study is to examine the predictive qualities of the Student Numeracy Assessment & Practice (SNAP) relating to the Foundation Skills Assessment (FSA). The study's methodology examines the correlations between student performance on SNAP and the Foundation Skills Assessment (FSA) while triangulating these assessments with reading achievement, math letter grades, and student perception of math efficacy. Controls for the study include socio-economic status, special educational designation, ethnicity, and gender. The research questions are:

1. *Does student performance on grade six SNAP assessments predict achievement on Provincial Numeracy Assessments (FSA grade seven)?*
2. *Do independent variables (reading achievement, classroom math achievement, and student self-perceptions of math efficacy) impact student achievement on SNAP and FSA?*
3. *Do control variables (gender, ethnicity, special education designation, and socioeconomic status) influence student achievement on both SNAP and FSA?*

Brief Overview of Methods

This study's methodological approach involves the correlation of Chilliwack School District student cohort achievement data in the 2018/19 and 2019/20 school years. The students studied were in grade six in 2018/19 and grade seven in 2019/20. There are 786 students in the cohort. This quantitative study will feature:

- Data on student performance on SNAP and FSA.
- Reading achievement as measured by the reading component of FSA 7
- Math letter grades as recorded by grade 6 report cards
- Student perception of math as collected by the grade 7 Student Learning Survey

The study will control for these variables:

  - Gender
  - Aboriginal/Non-Aboriginal
  - Special Education Designation
  - Socio-Economic Status (SES)

Triangulating student achievement on SNAP and FSA through the relationship between reading, classroom letter grades and student perception of math efficacy, may highlight nuanced differences between SNAP and FSA. For instance, SNAP is promoted by the Chilliwack School District as a mathematics assessment that does not require students to read material (such as word problems) to answer the questions. Therefore, it is reasonable to suggest that reading achievement might be more highly correlated to FSA math achievement than SNAP achievement. Furthermore, both SNAP and FSA are intended to assess grade six math curriculum. Correlating SNAP and FSA scores to grade six report card letter grades points to validity, because it is reasonable to predict that both SNAP and FSA achievement might have strong correlations to student classroom achievement.

Significance of Study

Change in education is difficult for teachers, even when research, results, and curriculum demand it (Davis, K. 2003; Negreiros, M., 2017; Webster et al., 2012). University of Kansas

Professor Rick Ginsberg explained that when someone asks a teacher to change their pedagogy, it is similar in scope to a religious conversion due to deeply held personal beliefs and practices (Personal Communication, 2020). This study is significant because it can add credibility in using competency-based assessments not just for formative purposes but for summative evaluations as well. Teachers might look to this research to help them adjust deeply rooted assumptions and impact what they do in their classrooms - ultimately benefiting students.

Examining the relationship between SNAP and FSA achievement is a timely study for the Chilliwack School District and the educational system. The District has spent considerable resources over the past four years to hire helping teachers and prepare classroom teachers to administer, interpret, and intervene with teaching strategies to help students learn mathematics. In years one and two of the implementation, all teachers in grades 2-7 were released from their classrooms for a minimum of two half-day training sessions. In years three and four, the training opportunities have been optional (provided after school hours) or by teacher request. The SNAP has been the focus of these training sessions and, combined with the FSA, is the District's measure of a numerate student.

Current research cites effective assessment protocols as essential for implementing quality teaching practice (Mertler, 2009; Stiggins & Chappuis, 2005). Furthermore, Stiggins (2017) names the current situation in education an “assessment crisis”:

> …students are at risk because our national, state, local district, school, and classroom assessment systems very often do not yield the kinds of evidence required for sound instructional decision making where it matters: in the classroom. Typically, these systems provide only gross indicators of student achievement that cannot inform the classroom-level instructional decisions that truly drive school quality (p.5).

Even in such a crisis, most British Columbia system leaders continue to promote traditional (content-based) mathematics assessment practices. These practices do not fully align with current research (competency-based) or the mandated curriculum as shown by continued provincial wide use of FSA. The irony is that the Ministry of Education mandates both the FSA and the competency-based curriculum. The FSA is not a poorly written or ineffective assessment; it is just is not designed to help classroom teachers. The FSA is created as a 'system check' for the province, providing comparable data on how individual students, schools, and districts are doing in relation to content-specific curricular outcomes. It is an alignment with curricular competencies, which is a key component of the new curriculum, that the FSA is missing.

However, seven school districts in BC use SNAP as an aligned alternative, a competency-based mathematics assessment that is both formative and summative while at the same time providing learning experiences for the students through doing it. Educators view such an assessment as "for, of, and as learning" (Earl, 2006) – a unicorn of sorts in the educational world.

This study could point to areas where the SNAP might supplement, replace portions, or make obsolete the FSA. An assessment that closely aligns with the curriculum, is classroom friendly, shorter in length, and easier to grade would be a welcome addition to current teacher practice. If SNAP could also provide a system accountability check, it could be an attractive alternative to a Ministry of Education looking to take Provincial Assessment in a direction that aligns with classroom practice and curricular competencies.

A recent study supports the notion that classroom assessments can offer equal validity and reliability to high-stakes exams (Rimfeld et al., 2019). In the United Kingdom, a team of researchers studied over 5,000 students in a longitudinal study. It concluded that "teacher assessments could replace some, or all, high stakes exams" (Rimfeld et al., 2019, p. 1278).

Additionally, they found that "teachers can reliably and validly monitor students' progress, abilities and inclinations" (p. 1278). This study endeavors to replicate some of these findings by looking for connections between SNAP and FSA.

Large-scale competency-based numeracy assessments are rarely used in the public school system in Canada. After an exhaustive search, SNAP notwithstanding, other examples of large-scale competency-based assessments appear non-existent. This study examines the SNAP validity and reliability and how it compares as a competency-based assessment in relation to a commonly used content-based assessment, the Foundation Skills Assessment (FSA). This study is important as the research could pose new thinking and processes in how teachers and educational system leaders assess student achievement.

Conclusion

Assessment practice connects to teaching practice; as Dunn and Mulvenon (2009) state, "…teaching practices can and should be informed by and coincide with assessment practices and outcomes" (pg 3). Assessment is an important area for educational leaders to focus their attention on because I believe what we measure, we pay attention to, and what we pay attention to - we teach. "For assessment to function formatively, the results have to be used to adjust teaching and learning" (Black & Wiliam, 1998, pg. 4). The big idea behind competency-based assessment use is that the assessment directly impacts what the teacher does next in their classroom. This research study delves into the validity and potential impact of the SNAP assessment, one that asserts its potential as an essential pedagogical approach in mathematics instruction.

The researcher believes that a potential correlation exists between student performance on the SNAP assessment and the FSA assessment. Students performing well on the SNAP should perform well on the FSA. Students who perform poorly on the SNAP should also perform less well on the FSA. This question, combined with the impact of the independent and control variables, is the focus of the remainder of the dissertation. Chapter 2 presents a thorough review of the literature - notably examining how SNAP, a competency-based assessment, aligns with research-supported instructional and assessment methods. Chapter 3 focuses on the methods used in this quantitative study, with particular attention to nuanced approaches explaining the potential impact of independent variables. Chapter 4 and 5 explain the study results and discuss the analysis - in that order.

Chapter Two: Framing the Study

Chapter two provides an overview of the philosophical assessment and instructional models that underpin this study and provides the necessary context for understanding assessment “best practices” in mathematics classrooms. The chapter opens by explaining the validity and reliability of the Foundation Skills Assessment (FSA). This is followed by discussing models and strategies that connect directly to the assessment tool (SNAP) by associating mathematical learning to research-based classroom assessment strategies. To add context to the study, I present a brief overview of prior action research connected to the Student Numeracy Assessment and Practice (SNAP). Finally, the chapter will explore connections to the study's independent and control variables, including reading achievement, classroom math achievement, self-efficacy, gender, socio-economic status, special education designation, and ethnicity.

Context

FSA Validity and Reliability

Since this study is looking at the relationship between SNAP and FSA, it is helpful to have a clear understanding of what FSA is, how it is measured, and how valid and reliable it is. The FSA is a large-scale assessment administered to all grade four and seven students in the Province of British Columbia (BC). BC teachers and administrators develop it, and Ministry of Education staff oversee the work. The FSA assesses reading, writing, and numeracy, primarily connected to multiple content strands in the BC curriculum. In contrast, the SNAP primarily measures the BC curriculum's competency strands, connected to only two content areas. The FSA is a combination of selected response / multiple-choice and open response questions. The selected response portion of the test is completed by students online and graded automatically by the online computer system. The open response questions are completed by students with pencil and paper and are graded later by teachers. The computer system provides a systemic approach to grading the multiple-choice questions but scoring the open response questions is more complicated. Based on the work of Oliveri, Gunderson-Bryden, and Ercikan (2012), the following paragraph provides an abridged description of the five steps that the BC Ministry of Education has undertaken to address consistency and reliability in scoring the FSA questions.

The first step in creating the FSA is for the test designers to apply consistent assignment of scores to each question by connecting curriculum outcomes and score weightings. Secondly, the Ministry created a model for scoring the questions. The multiple-choice questions are scored immediately via the online system (these are closed response questions), and the open-ended questions need to be scored by staff. The Ministry uses a decentralized model, a model where the scoring takes place in school districts. In this model, the individual districts are responsible for training teachers and facilitating the scoring. To aid with the localized scoring of the FSA, the Ministry created scoring rubrics and exemplar answers in this step of the process. These tools help with reliability and common expectations during marking sessions. The fourth step involves the training of the scorers. Using the rubrics and exemplars as training materials, scorers are trained locally in each district to ensure consistency before scoring the FSA. The final and fifth step of the process involves monitoring scores by double scoring select responses in two ways. First, local scorers double score some of the students' work during the local marking session. Second, the Ministry collects samples from each district and scores them again for consistency (Oliveri, Gunderson-Bryden, & Ercikan, 2012).

The student scores in numeracy FSA are scaled and standardized using Item Response Theory that weights the difficulty of item level questions, compares student responses from one year to the next, and creates predictive ability ratings for each student (Mailman School of Public Health, n.d.) The Ministry calculates the raw scores using this algorithm, and the "scaled scores range from 200 to 800 with a mean of 500" (MacLeod & Emes, 2018, p. 4).

FSA Test Features

Table 2.1 shows the breakdown of the grade 7 FSA numeracy assessment from 2019. Note the high number of questions (33), touching on most, if not all aspects of the curriculum's content areas. Questions 1-30 are selected response / multiple choice questions, with questions 31-33 being short answer – requiring pencil and paper to complete. Sample questions from the FSA Assessment are shown below this table.

Figure 2.1 on page 28 provides an example of a selected response question from the grade seven 2019 Sample FSA Assessment (Foundations Skills Assessment Samples, n.d.-b). Students complete these questions in an online format, using a computer or iPad. They need to read the question, understand what is being asked, and then select the most appropriate response.

Figure 2.2 provides an example of a short answer question from the grade seven 2019 Sample FSA Assessment (Foundations Skills Assessment Samples, n.d.-b). The short answer questions require students read the question, understand the context, and then use a pencil and paper and show all their work in a paper booklet.

Competency-Based Education (CBE) Defined

This study focuses on student performance from a competency-based assessment (SNAP) to predict achievement on a traditional selected response/short answer summative assessment (FSA). A strong correlation between the two assessments could elevate the use of competency-based assessments for summative purposes in education.

> Competency-based education seeks to transform teaching and learning in the nation's elementary, middle, and high schools. It is a major shift in school culture, organization, structures, and pedagogy. It challenges and deconstructs the traditional, time-based, one-size-fits-all approach to public education, which has changed very little since its Industrial Age beginnings (Aurora, 2019, p.1).

Table 2.1 Breakdown of 2019 Grade 7 FSA Numeracy Assessment

Content	Item	Item Descriptor
Number/Computational Fluency	1	Demonstrate understanding of a simple division to solve a problem.
Data and Probability	2	Use the proper procedure to determine the probability in one random pick.
Patterning	3	Identify a pattern rule by simple division.
Geometry and Measurement	4	Use a referent or formula to find area of simple composite shape.
Number/Computational Fluency	5	Solve a problem using multiplication.
Number/Computational Fluency	6	Solve a problem using addition and multiplication.
Data and Probability	7	Understand and interpret a bar graph.
Geometry and Measurement	8	Compare the area of rectangular-shaped spaces by their length and width.
Patterning	9	Identify and complete an increasing pattern.
Patterning	10	Identify an increasing pattern and determine the missing term.
Number/Computational Fluency	11	Calculate the difference between two decimal fractions.
Data and Probability	12	Demonstrate an understanding of single outcome probability.
Number/Computational Fluency	13	Determine a fraction when given the part of a whole.
Patterning	14	Identify and extend a pattern.
Geometry and Measurement	15	Perform a transformation of a given object.
Number/Computational Fluency	16	Identify a measurement from a referent.
Number/Computational Fluency	17	Identify factors of a given number.
Geometry and Measurement	18	Solve a problem using addition and division.
Number/Computational Fluency	19	Find an area using a personal referent
Patterning	20	Calculate the percent of a whole for a given image.
Geometry and Measurement	21	Calculate the elapsed time and duration.
Patterning	22	Extend a pattern to find the nth term.
Number/Computational Fluency	23	Use basic number operations to solve a problem.
Number/Computational Fluency	24	Convert coins to smallest number of paper money and coins.
Geometry and Measurement	25	Determine the areas of different shapes (triangles, rectangle and parallelogram).
Number/Computational Fluency	26	Identify a part to whole ratio from a given situation.
Patterning	27	Identify an expression to find the nth term of a pattern.
Geometry and Measurement	28	Determine perimeter and convert from metres to kilometres.
Number/Computational Fluency	29	Determine the value of expressions.
Data and Probability	30	Determine the probability in one random pick.
Number/Computational Fluency	31	Use evidence, reasoning, and planning to solve a problem to determine a combination that satisfies the conditions outlined.
Data and Probability	32	Use evidence, reasoning and planning to determine if two probability experiments are fair.
Geometry and Measurement	33	Use evidence, reasoning and planning to calculate the areas of a variety of shapes given a set perimeter and determine the shape which has the greatest area.

Figure 2.1 Grade Seven FSA Selected Response Sample

7. While walking on the beach, Raj found mussels.

He counted a total of 320 mussels.

One clump of mussels was about 15% of all the mussels.

About how many mussels were in that one clump?

30	40
50	60

Figure 2.2 Grade Seven FSA Constructed Response Sample

3. Selena and Amritha accept the Trail Challenge.

They start at opposite ends of the 30 km trail and move toward each other.

Selena walks the trail at a rate of 4 km/h.

Amritha bikes the trail at a rate of 6 km/h.

If they start at 10:00, what time will they meet on the trail?

Show all of your work.

The big idea of competency-based learning is that it is different from the traditional curriculum. A traditional curriculum prescribes a set amount of time for learning specific goals. For example, teachers have weeks to teach a math unit on fractions, regardless of whether their students learned the content or not (Twyman, 2014). A competency-based curriculum does not prescribe the time dedicated and instead focuses on demonstrating student learning – either in less or more time (Twyman, 2014). Also referred to as performance, mastery, or proficiency-based, for this study, competency-based assessment connects to assessing the curricular competencies (Table 2.2) of the BC Curriculum (BC Ministry of Education).

Competency-based education is relatively new on the educational scene. As recent as 1976, competency-based education (CBE) faced questioning, "is it a fad, or is it an innovation to be seriously considered, evaluated, and given a fair trial" (Semmel & Semmel, 1976, p. 69)? Understanding the context of CBE is important to this study because SNAP could be a bridge between the old and the new; it could be a transformational shift in instructional pedagogy by reimagining a CBE approach to assessment in a replicable way.

Table 2.2 BC Ministry of Education Mathematics Curricular Competencies

Curricular Competency Elaborations +

Students are expected to be able to do the following:

Reasoning and analyzing

- Use logic and patterns to solve puzzles and play games
- Use reasoning and logic to explore, analyze, and apply mathematical ideas
- Estimate reasonably
- Demonstrate and apply mental math strategies
- Use tools or technology to explore and create patterns and relationships, and test conjectures
- Model mathematics in contextualized experiences

Understanding and solving

- Apply multiple strategies to solve problems in both abstract and contextualized situations
- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and representing

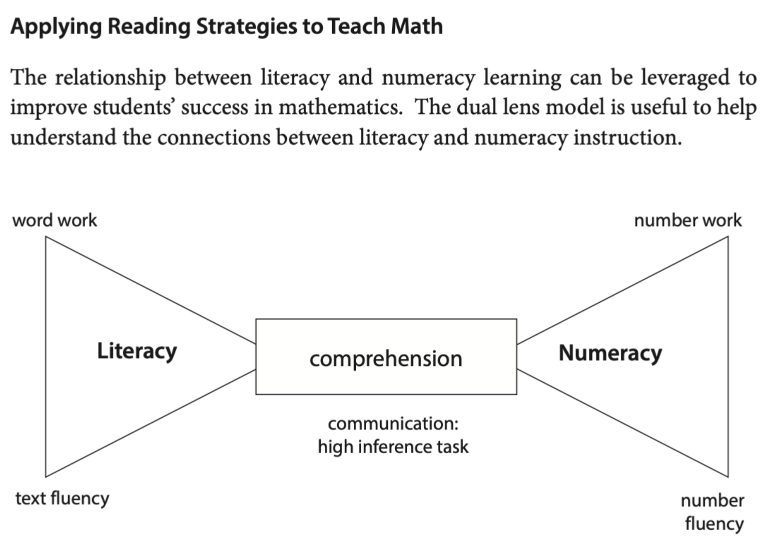
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Communicate mathematical thinking in many ways
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Use mathematical arguments to support personal choices
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

The book *Adding it Up* (2001) outlines five mathematical proficiencies (aka competencies) that capture what it means to learn mathematics successfully. They include conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. Of note is the idea that these competencies are "interwoven and interdependent" (National Research Council 2001, pg. 5). The Dual Lens Model (Bird & Savage, 2014) illustrates the connection between reading and these numeracy competencies. It shows that literacy and numeracy include skill acquisition (number/word work), fluency (number/text), and comprehension as building block components of a balanced reading and mathematics program (Figure 2.3). “Literacy activities, designed to help students negotiate and create text, can be adapted for use in math classrooms” (Draper, 2002, p. 538).

Figure 2.3 Dual Lens Model (Bird & Savage, 2014, pg.55)



- Number Work includes the skill development of traditional calculations and algorithms (procedures) of math.
- Number Fluency relates to the concept of automaticity – if one can do a task fluently, their conscious brain processing power can complete other executive functioning tasks. Schneider (n.d.) suggests that automaticity in cognitive function frees up 90% of working memory for higher-order skills. The mathematical tasks in this area include rapid recall of

times tables, math facts, and practice in all math curriculum areas (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977).

- Comprehension includes the ability to conceptualize, analyze, apply, and interpret mathematics.
- Communication is the ability to share thinking through oral/written means or performance.

As discussed, the SNAP was born from researched competency-based literacy practices, and substantial research supports the benefits of such an approach in mathematics as well (Roepke & Gallagher, 2015; Zollman, 2009). “It is not a matter of conceptualizing entirely new methods for teaching mathematics, but rather of incorporating the established methods described by literacy educators with math instruction” (Draper, 2002; p. 538). To emphasize, Draper says that educators do not have to ‘reinvent the wheel’ to teach CBE curriculum in math classes. Those same strategies that work in literacy can be equally effective in the math classroom.

Table 2.3 depicts key literacy strategies and connects each strategy to a similar approach in math instruction. Further discussion of these strategies will be explored later in this chapter.

Table 2.3 *Alignment of Literacy and Numeracy Strategies*

Literacy Strategy	=	**Numeracy Strategy**
Making Predictions		Estimating
Visualization		Representation / modelling
Connecting text to text, text to self, text to world		Real-Life Connections
Metacognition		Reflection

Assessment Assumptions

An important premise of this study is that student assessments have three main functions for educators (Stiggins, 2002, 2014):

1. As a formative assessment – for learning

2. As a summative assessment – of learning

3. As a learning experience – as learning

“Assessment as teaching and learning. Assessments and instruction can be one and the same, if and when we want them to be” (Stiggins, 2014, p. 1). Students can learn when doing - even when teachers are evaluating them while doing the task. The difference, as Stiggins notes, is that teachers need to be purposeful about whether they want learning and assessment to happen simultaneously.

What is different about SNAP is the assertion that an assessment can do all three versions of assessment (for, of, and as) concurrently when designed correctly. Such an assessment design is both open and authentic. An 'open' assessment is where students can show their learning in various non-predetermined ways, and authenticity happens when students can make personal or real-life connections to their learning tasks (Shepard, 2000).

An assessment that is open by design could be a valuable learning tool to help students and teachers find learning gaps, practice skills, and finally demonstrate mastery – due to a higher cognitive strategic load in solving problems and metacognition (O'Neil & Brown, 1998). The idea of a standardized practice ‘able’ assessment, one done repeatedly – while providing feedback through formative assessment practices is not widespread; but there has been movement toward the use of standardized formative assessment that informs instructional practices and student learning (Kerr et al., 2006; Lang & LaVenia, 2015). A version of such assessment practices is explained in Liljedahl's 2020 book *Building Thinking Classrooms in*

Mathematics. He describes using vertical surfaces in classrooms for students to show their work visibly. Using whiteboard walls around the class exterior creates an environment for teachers to provide formative assessment feedback while their students work through problems. Liljedahl describes this as a recommended practice but does not provide a standardized assessment protocol for this approach.

The impact of finding tasks that align with 'for, of and as learning' is that a formative assessment, upon successful demonstration of learning, becomes a summative assessment – simultaneously. Bell and Cowie (2000) discuss this idea, as does Dunn and Mulvenon (2009). They (Bell & Cowie, 2000; Dunn & Mulvenon, 2009) assert that it is how the assessment data are used that determines the label we give the assessment. For instance, a test that students struggle with can inform the teacher that students need further teaching or are not learning. Acting on this information would make the assessment formative in nature. If the teacher used the same data to fail or pass students, the assessment would be summative in practice. Educators can use the same evaluation in multiple ways to achieve differing ends. Bell and Cowie (2000) go on to explain how formative assessment can morph and teachers can use it for teaching conceptual development, "In taking into account students' thinking in their teaching, teachers are responding to and interacting with the students' thinking that they have elicited in the classroom. They are, therefore, undertaking formative assessment while teaching for conceptual development" (p. 538). Their idea of teaching for conceptual development aligns closely with the third way SNAP is a tool for assessment – it is a learning experience termed "as learning" (Manitoba Education, Citizenship and Youth, 2006). At this junction between assessment and learning, SNAP is making its claim as a transformative assessment tool, an assessment 'as' learning. If SNAP achievement is predictive of FSA achievement, then the assessment attributes become value-added bonuses to the educational experience.

Characteristics of SNAP

The purpose of this part of the literature review is to explain the relevance of mathematics instructional strategies that researchers recommend for effective classrooms. This background will connect directly to understanding the philosophy underpinning SNAP. Chapter One explained that SNAP asserts itself as an assessment that can do more than a system check on accountability for math proficiency, and this section highlights example approaches.

SNAP Assessment Format

Table 2.3 shows an overview of the inner workings of a SNAP assessment (Chilliwack School District, 2016). There are two parts to each of the two, one-page templates. Item one of the assessments is shown in the 'content' column of Table 2.3 and is named 'Number Sense'. The item's descriptors are explained in the third column, explaining the kind of thinking and work that students must complete. This focus on curricular competencies is similar for item two, where students show what they know in relation to a mathematical operation. Note the difference in language between the FSA item descriptors on Table 2.1 (page 26) and those on the SNAP. SNAP asks the students to go deeper with their explanations, thinking, and demonstration of learning.

The following sections will explain the philosophical building blocks of the SNAP assessment in further detail, connecting the activities shown in Table 2.3 to researched best practices.

Making Predictions (Estimating Strategies)

Making and justifying a math prediction is critical in demonstrating an understanding of mathematical concepts and can include self-checking the math calculation. Estimating techniques assist students in making close guesses that demonstrate conceptual understanding and real-life connections. Key estimation strategies are found in strong mathematics students and include number skills, number sense, cognitive processes, and affective attributes (Reys, 1982; Reys & Yang, 1998; Simms, Clayton, Cragg, Gilmore, & Johnson, 2016). “Estimation may be used more often in everyday life than any other quantification process” (Siegler, R. & Booth, J., p. 197). The SNAP has a portion of the assessment focused on the student’s ability to estimate the answer and provide justification.

Table 2.3 Breakdown of 2019 Grade 6 SNAP Numeracy Assessment

Content	Item	Item Descriptor
Number/Computational Fluency (Number Sense)	**1**	Demonstrate understanding and application of a decimal fraction through the lens of the curricular competencies (reasoning and analyzing; understanding and solving; communicating and representing; connecting and reflecting).
Draw	1	The picture must show the value of the number.
Skip Counting	1	Begin at the number and counts forwards and backwards from the numbers chosen by the teacher.
Equations	1	Students who are demonstrating full proficiency will be using grade appropriate operations in their equations.
Real life example	1	The examples must be realistic and specific. It is important that students demonstrate their understanding of value in their example.
Number Line	1	Students in grade 6 choose their own endpoints according to the number chosen for the assessment. Students add benchmarks to the number line to help situate the number.
Reflection	1	Reflections help increase the value of a learning experience. They allow students to link ideas and construct meaning from their experience.
Number/Computational Fluency (Operations)	**2**	Demonstrate understanding and application of division of four-digit number to hundredths by one digit number through the lens of the curricular competencies (reasoning and analyzing; understanding and solving; communicating and representing; connecting and reflecting).
Estimate	2	Students will select and use an appropriate strategy for the given operation.
Draw	2	Students will visually represent the operation. A visual may or may not contain the solution to the operation. Consider the use of bar diagrams as an appropriate, proportional model for the operations.
Calculate	2	Multiple grade appropriate calculations demonstrate proficient achievement. Using the reverse operation to "check" their work is also a recommended strategy.
Real life example	2	Students will provide details on a real-life situation where the given operation would be used to find an amount. Look for evidence that communicates their understanding of the use of the operation.
Reflection	2	Reflections help increase the value of a learning experience. They allow students to link ideas and construct meaning from their experience.

Imaging Strategies

Taking the abstract and creating concrete modeling is an essential skill for mathematicians. An effective approach when teaching mathematics is for teachers to provide students with concrete manipulatives and then connect these concrete examples to symbols and abstract concepts (Uttal, Scudder, & DeLoache, 1997). Demonstrating learning is the opposite of this teaching technique. By creating concrete representations, students can demonstrate their comprehension by applying a concept to a real-life example. These models can be in the form of a drawing, a manipulative, a graph, or even a mental image. Indeed, conceptual understanding is not possible without the ability to image, as imaging is a crucial stage of comprehension (Bird & Savage, 2015; Bower & Morrow, 1990). Additionally, it is helpful when students can demonstrate their work and understanding in an open-ended multi-representational fashion. This approach caters to students with different skills, backgrounds, and dispositions, and "providing that the result is reasonable, the pathway and mode of representation are valued" as learning experiences (Zevenbergen, Niesche, Grootenboer, & Boaler, 2008, p. 642). The SNAP requires students to demonstrate their understanding of the math concepts through drawings, sketches, and representations on the page – a multi-representational approach.

Open vs. Closed Assessment

Open-ended questioning in math can support higher achievement levels as students are required to consider multiple approaches and options to find solutions (Lee et al., 2012). Open-ended questions "induce more cognitive strategy" use than closed questions such as multiple choice or right/wrong answers (O'Neil, 1998). A 3-year study involving students from two different schools found that students who are taught regularly from a pedagogy of open-ended activities performed better than students taught in a more traditional, textbook-based approach

(Boaler, 1998). A similar study by Çakır and Cengiz (2016) also showed improved student engagement and achievement when educators taught using open-ended questioning techniques in elementary classrooms.

A closed assessment, on the other hand, is one where there is a predetermined correct answer. An example of a closed assessment is a multiple-choice test or a math quiz where students calculate a correct answer. When teachers use a traditional closed mathematics approach to assessment & instruction, their students primarily develop procedural knowledge (Boaler, 1998). This procedural knowledge is of limited use to students in novel situations (Boaler, 1998). The SNAP is an opened ended assessment. The assessment begins with a conceptual question called a "doorway question" (Bird & Savage, 2014, p. 11). The student uses their background knowledge and experiences to explain their understanding to answer the question.

Real-Life Connections

Helping students make real-life connections to math is another foundational piece of mathematical proficiency, enhancing student understanding of concepts, motivating learning, and helping students apply mathematics to authentic problems (Gainsburg, 2008). In a literacy context, Keene and Zimmerman (1997) concluded that the best approach to real-life connections is to help students make text-to-text, text-to-self, and text-to-world connections. These connections are crucial for student engagement and understanding and are also a way to address confidence and self-efficacy (Stoehr, 2015). "The pedagogical practice of connecting mathematical content to real-world contexts, particularly contexts relevant to students' knowledge and experiences, can positively impact student motivation as well as promote conceptual understanding" (Sugimoto, Turner, & Stoehr, 2017, p. 1). The SNAP requires students to apply the math concept from the assessment to a real-life context. This process helps to take the math concept from abstract thinking the concrete.

Metacognitive Strategies

Teaching students how to improve their metacognitive skills significantly impacts their understanding and achievement in all teaching domains, including mathematics (Hattie, 2009). The term metacognition refers to an individual's awareness and ability to control their thinking processes. Another definition is 'thinking about thinking.' In multiple studies by Ozsoy and Ataman (2009, 2011), grade 5 students who were explicitly taught metacognitive strategies performed significantly better in mathematical problem-solving achievement than control groups that received no training. In another study by Thomas (2006), students who were explicitly taught metacognitive skills showed enhanced abilities to complete problem-solving processes. "The ability to think about, and reflect on, the problem-solving process is an important component of learning mathematics" (Thomas, 2006, p. 86). The SNAP requires students to reflect at the end of the assessment on their thinking and learning. Prompts for students include, "what was easy, what was difficult, and what do I still need to learn?" (Chilliwack School District, 2016).

Cultural Sensitivity & Competence Teaching

Moule (2011) defines cultural competence in the educational setting as "the ability to successfully teach students who come from cultures other than your own" (p.5). Maya Angelou, a civil rights activist, is credited with the quote, "Do the best you can until you know better. Then when you know better, do better." Angelou's sentiment is playing out in schools across British Columbia, where educators focus on improving equity and inclusion for all students. "As schools work toward equity, they will narrow the gaps between the highest- and lowest-performing groups and eliminate the racial predictability regarding which groups achieve in the highest- and lowest-performing categories" (Singleton, 2015, p.6).

The SNAP, by design, is culturally sensitive. Because the assessment requires students to create their own "real-life connections" with the mathematics concepts, they can draw upon their life experiences. This authentic connection means that the assessment does not impose on the students an unfamiliar mathematical situation or story that requires background knowledge to access the context. Students can think in their native language to present their understanding of mathematical concepts and learning, an important principle of creating equitable practice in diverse classrooms (Zevenbergen et al. 2008).

Assessing Math – Not Reading

There is a significant connection between reading fluency skills, reading comprehension ability, and performance on word problems in math (Björn et al., 2008). Because the SNAP focuses on bringing student background knowledge to the assessment, there is no requirement for students to read contextual material. They simply interact with math and do not have to use reading comprehension strategies to figure out the question. This difference can potentially better assess students who have high math ability and low literacy skills. International students, bilingual students, or any student who struggles with reading could potentially demonstrate improved math achievement when using this assessment because language is less likely to get in the way.

Reducing Math Anxiety

The research of Finlayson (2014) asserts that several factors cause student math anxiety, including strict adherence to fixed curriculum, a reliance on closed (right/wrong) assessment practices, and a teaching approach that promotes outcomes over process. Her research supports a constructivist teaching approach that values process over product and relies on a deeper dive into conceptual math understandings to overcome math anxiety in classrooms. Number talks (also referred to as math talks) are strategies that teachers use to improve student learning in mathematics classrooms by focusing on mathematical processes and reducing math anxiety (Boaler, 2014). Instead of worrying about answering 50 questions on a timed test, students can spend learning and thinking time on one question at a time during a number talk. Much like number talks, SNAP supports a deep dive into one question. The assessment is one page long and uses a graphic organizer and a scaffolded approach. One question may not be as daunting for proficient students by producing less test anxiety and ensuring that students have the time to show what they know more accurately (Bird & Savage, 2014).

Diagnostic Assessment

Popham (2009) defines a diagnostic test in education as “a test that helps identify a student's learning problems so teachers can provide instruction to remedy those problems” (p. 90). Additionally, he explains that many education assessments claim to be diagnostic yet do not hit the mark. He concludes the article stating that for tests to be “truly diagnostic,” they need to meet several criteria:

(1) Measure a modest number of significant, high-priority cognitive skills or bodies of knowledge;
(2) Include enough items for each assessed attribute to give teachers a reasonably accurate fix on a test taker's mastery of that attribute;
(3) Describe with clarity what the test is assessing; and
(4) Not be too complicated or time-consuming. (Popham, 2009, p, 91)

Based on Popham’s criteria, the SNAP fits as a diagnostic assessment for educational purposes. It measures a modest number of high-priority skills, asks enough from students to give teachers a clear picture of student proficiency, is clear on assessment outcomes, and students can complete it in a short amount of time (10-15 minutes per assessment). In 2011 the BC Ministry of Education identified the ANIE (and by association the SNAP) as a recommended assessment resource in their publication, *Supporting Students with Disabilities: A Guide for Teachers* (p.172, 175). A large-scale assessment that has diagnostic uses could be a valuable tool in the classroom teacher's toolkit and connects directly to helping students who struggle in mathematics, while also providing accountiblity for the system.

Response to Intervention

Teachers work every day with our young students, striving to help them become improved versions of themselves. Teachers need to be current in teaching methodologies so that they have maximum impact. One of the most lauded teaching approaches in North America is Response to Intervention (RTI), sometimes also referred to as Multi-Tiered Systems of Support (MTSS). In this approach, educators support students through a three-part framework.

1. Universal high-quality instruction for <u>all</u> students
2. Systematic identification and support for <u>some</u> students who need support
3. Small group or individual support for a <u>few</u> students who still need support

Unfortunately, even though there is widespread attempted use of RTI and MTSS, there is a lack of teacher understanding and proper implementation of these structures (Buffam, M., Mattos, M. & Weber C., 2010, Nagro et al., 2015). "Teachers lack confidence in their understanding of RTI and make instructional and behavioral decisions based on factors other than research support (Nagro et al., 2015, p. 57)."

For RTI to thrive in a school, teachers need assessments that supply valuable information to teachers to differentiate their students' instruction. Buffam, Matteos, and Weber (2010) recommend using common assessments in a school so that teachers are collaborating to meet their students' needs. They assert that ideally, "teachers would create common assessments to compare results and determine which instructional practices were most and least effective" (p.

5). When teachers can increase effective practice and cull ineffective approaches, students benefit.

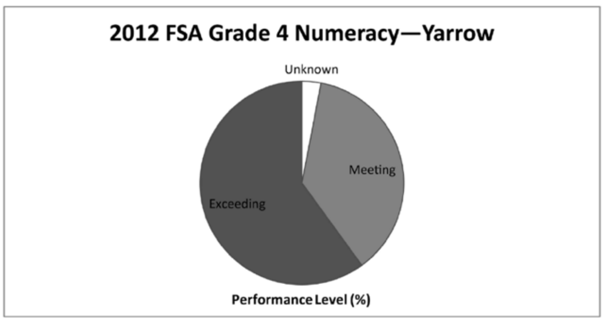
SNAP is a standard assessment that teachers could use as a universal screen. It could help teachers make data-driven decisions and plan collectively for tiered intervention supports, whether the lesson needed is for the entire class, a small group of students, or an individual.

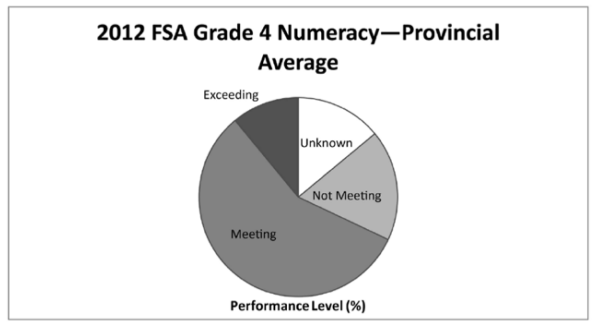
Prior Action Research – The ANIE / SNAP Connection

The Assessment of Numeracy in Education (ANIE), and by association – the Student Numeracy Assessment and Practice (SNAP), share a philosophy based on a theory that a balanced approach to assessing and teaching mathematics could mirror a balanced literacy approach. Both assessments are designed to assess student math competencies (thinking, application, conceptual understanding) and enhance the traditional assessment of calculations and algorithms. These comprehension strategies are cross-curricular, and studies have shown that research-based practices proven effective in reading are also applicable in the math context (Bird & Savage, 2014; Draper, 2002; Hyde, 2006; Sammons, 2011). The idea is that by learning more about how students think, teachers can help their students develop metacognitive skills. The action research conducted connected to the ANIE included two elementary schools in British Columbia and examined the implementation impact on FSA achievement in grades 4 and 7. The action research found that in both schools where teachers used ANIE with consistency, student achievement on FSA improved (Bird & Savage, 2014).

The ANIE story is significant for this study because 'Operation SNAP' is a replication of ANIE. Even though it does not have the same template, the' Number Sense SNAP does share the same philosophy by requiring students to demonstrate their conceptual understanding of the math on a one-page template. Figure 2.4 below shows an example of the achievement from Yarrow Community School in Chilliwack, British Columbia. The school showed achievement levels well above the provincial average as per the FSA, with 60% of grade 4 students performing at the exceeding level (Bird & Savage, 2014). This study informs the current study by highlighting a link between classroom use of ANIE and increased performance on the FSA. The current study will dig deeper into the connections between these two assessments to determine if there are predictive qualities of SNAP achievement on FSA achievement.

Figure 2.4 Yarrow Elementary vs. Provincial FSA Achievement (Bird & Savage, 2014, p.65).





Independent and Control Variables

This section discusses the independent and control variables involved in this study. The independent variables discussed in this section include reading ability and math efficacy. Control variables included social-economic status, gender, reading ability, and ethnicity. Research has shown that each of these areas can significantly impact student achievement, and therefore, each variable's effect will be studied.

Social Economic Status

Social-economic status (SES) has documented connections to student achievement. The higher the SES, the better the achievement (Sirin, 2005). In a study completed in 2018 by the Fraser Institute in British Columbia, their research compared student achievement on the Foundation Skills Assessment (FSA) between public and private schools. Typically, SES is a predictor of how well schools will perform, with lower SES resulting in lower student achievement. However, this research found that "even though families with non-elite independent schools have virtually the same after-tax family income as families with students in public schools, non-elite independent schools score higher on FSA exams" (Macleod & Emes, 2018). This finding connects directly to the narrative of public schools underperforming private schools and not SES. However, the key concept is the diminished predictive power of SES due to the factors attributed to independent (private) schools.

The study will calculate SES using median average family income associated with postal code addresses. Students' demographic information contains postal codes, and this study can use that same data.

Gender

Research has shown that gender influences student achievement (Llyod, Walsh, & Yailagh, 2005; Voyer & Voyer, 2014). In a 2005 study by Llyod, Walsh, and Yailagh that focused on the effects of gender in British Columbia, they found that girls' mathematics achievement on the FSA met or exceeded boys' achievement. Additionally, in a meta-analysis using 329 research samples, Voyer & Yoyer (2014) found that female students had a significant advantage on academic achievement scores. They found that the advantage was more pronounced in literacy-based academics but still had significance in mathematics as well (Voyer & Yoyer, 2014). This study looks at the extent to which gender differences account for variance between FSA and SNAP.

Reading Ability

Earlier in this chapter, there was presented research explaining that effective instruction in reading can mirror effective mathematics instruction (Draper, 2002; Roepke & Gallagher, 2015; Zollman, 2009). Connected to this idea is that reading ability is a predictor of math achievement. Generally, strong readers are also good mathematicians. There is a significant correlation between reading comprehension and mathematics achievement, particularly in problem-solving, application, and conceptual understanding (Grimm, 2008). FSA reading data from 2019 (grade 7) is an independent variable in this study.

Math Efficacy

Student self-concept and self-efficacy has been found to have strong correlations of mathematical achievement in academic settings for fifteen-year-old students (Parker et. al., 2014). Another study of 107 grade seven students showed that self-efficacy played a direct role in predicting students' math performance – and that student self-efficacy was connected to prior success in mathematics (Chen, 2003). This study uses data from the Ministry of Education's Student Learning Survey, where students answer question connected to their self-efficacy in mathematics (BC Ministry of Education, n.d.-c).

Special Education Designation

Students with special education designations in British Columbia do not perform as well academically as students who do not have special education designations (BC Ministry of Education, 2020). The graduation rate between these two populations, as reported in 2020 on the BC Ministry of Education website is 90% for all students, and 74% for students with special needs. This achievement gap exists throughout all academic measures.

Ethnicity

In British Columbia, Indigenous students' academic achievement is a well-documented concern based on FSA assessments and graduation percentages (BC Ministry of Education, 2020). This study will explore the extent to which being Indigenous is related to either SNAP or FSA.

Summary

This chapter provided an overview of the philosophical assessment and instructional models that underpin this study. Through connecting researched 'best practices' to assessment, I have offered a context for the importance of formative, competency-based assessment in mathematics classrooms. Additionally, I established a place for competency-based assessment within common educational structures such as RTI, MTSS, and special-education settings. Finally, I explained the study's control variables in context to similar studies involving student achievement measures.

There is compelling evidence that the competency-based assessment used in this study (SNAP) has a philosophic approach supported by mathematics researchers and experts. What is still in question is whether there is a significant correlation between this competency-based assessment and a large-scale standardized one. Chapter three will outline the methodology of the study, chapter four will reveal the results and chapter five will offer a discussion of the findings.

CHAPTER THREE: Methodology

Overview

The purpose of the study is to look for evidence that might elevate competency-based assessments in educational decision-makers minds. This evidence would need to demonstrate that competency-based assessments could serve as system-wide accountability measures that are as effective or more effective than traditional content-driven assessments. This particular study will correlate student performance between the SNAP 6 (a competency-based assessment) and the FSA 7 – a content-driven traditional assessment. The study's methodology will examine the correlations between student performance on SNAP and the Foundation Skills Assessment (FSA) while triangulating these assessments with reading achievement, math letter grades, and student perception of math efficacy. The study results will show whether (or not) SNAP 6 student performance predicts student achievement on FSA 7. If there is a strong positive correlation, this finding could revamp the provincial approach to large-scale standardized testing practices. If there is no strong correlation, further discussion and research will be required to substantiate the validity of the assessment in general and how these assessments (both competency and content-based) may or may not find alignment in 21^{st} curricular visioning.

This chapter outlines the methods and processes for this study. Further information on the design, data collection, variables, controls, analysis, analysis, validity, and reliability will be shared.

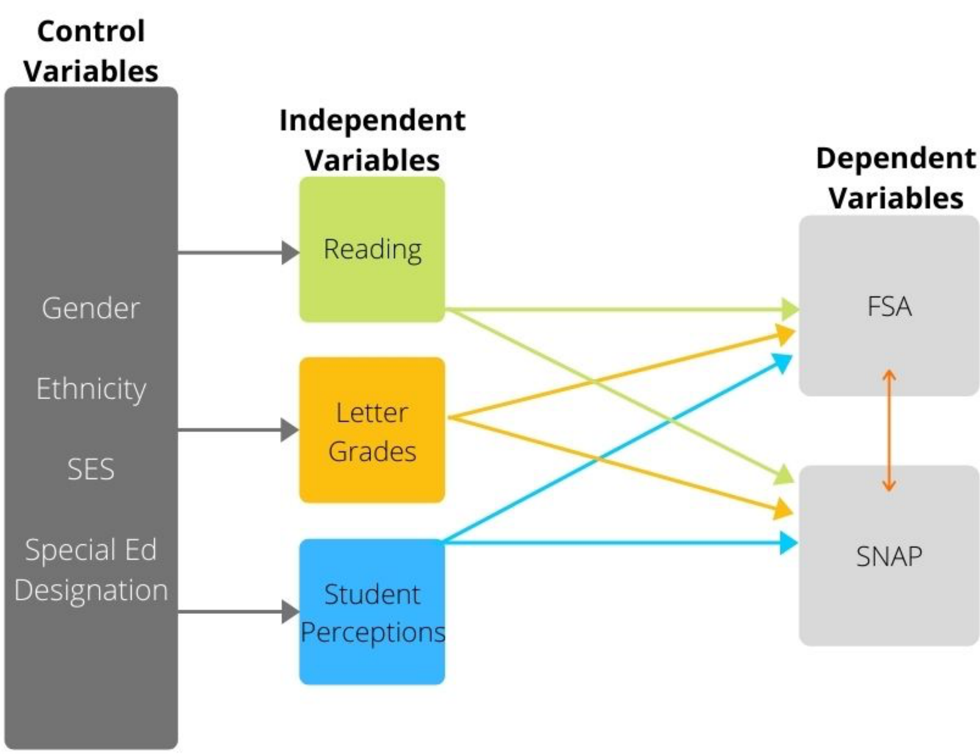
Design of the Study

This study uses a quantitative design, focusing on a correlational analysis approach. Because the study's objective is to determine the extent of a relationship between SNAP and FSA using existing statistical data, the correlational analysis approach is preferred. The study explores trends and patterns in the data. The study identified control variables that may explain nuanced relationships and elevate the research beyond a simple bivariate correlation research.

Figure 3.1 shows a conceptual diagram of the study, including the dependent, independent and control variables. The dependent variables, SNAP and FSA have a direct relationship to each other, shown by the two headed arrow. The middle row of independent variables (reading, letter grades, and student perceptions) each influence both SNAP and FSA differently. These differences will help to explain the similarities and differences between the SNAP and FSA assessments. The control variables in this model are shown 'on block' in dark grey, and are removed from the dependent variables, becaue they are used as controls only in the study.

Figure 3.1 *A Stylized Depiction of Estimates from Consecutive Models Testing Proposed Relationships*

Note: Two-headed arrows represent direct correlations. One-headed arrows represent multiple regression relationships.



Sample Selection

The sample selection of data uses pre-existing institutional information from a cohort of students in grade 7 during the 2019/20 school year. The researcher works in the Chilliwack School District and has access to these data. The study includes all the grade 7 students in the Chilliwack School District from all five middle schools. Two of the schools are urban 'inner city' schools, two are in affluent urban neighborhoods, and one school is rural. This cohort of students was selected because they are the most recent group of students who have written the FSA in their grade 7 year. These same students have written the SNAP in the spring of their grade 6 year and again in the fall of their grade 7 year. It is important to note that the content for SNAP 6 (spring) and SNAP 7 (fall) are the same. The study includes both data sets as independent variables, with SNAP 6 written in the spring of 2019 and SNAP 7 written again by the same students in the fall of 2019.

All students in the grade 7 cohort in the Chilliwack School District who wrote both the FSA Numeracy and SNAP are included in the study. If a student did not write either of these assessments, their data would not be used in the study. No students are interviewed in this study, and student identity is masked. The study is looking for large trends in the data, not individual narratives.

The FSA datasets contain much information that will be useful in the study beyond math achievement. Data points include names of schools, grade, ethnicity (aboriginal/non-aboriginal), gender, special-education category, and reading achievement. Additionally, there is a student personal identification number (PEN) that connects data to individual students.

The following table outlines the specifics of the sample population.

Table 3.1 Background and Demographic Characteristics of Study Sample

Variable	*n*	Valid %
Sample Size	786	
Gender		
Female	385	49.0%
Male	401	51.0%
Racial Group[1]		
Indigenous	133	16.9%
Non-Indigenous	653	83.1%
Binary Grouping Special Education		
Special Education Designation	116	14.8%
No Special Education Designation	670	85.2%

[1]For racial group, participants self-identified.

Ethical Considerations

The University of Kansas Human Research Protocols were followed throughout this study and the review and approved by the Institutional Review Board (IRB). All data in this study is historical institutial data. The data has been de-identified and is stored on a secure laptop computer that is password protected, encrypted and only accessible to the researcher. It will be stored for the duration of the study and then moved to a secure confidential file system on the Chilliwack School District network. Because the information belongs to the school district (institutional data), there is no need to delete it. Participant consent is not required as all information is institutional data. The Superintentdent of Schools provided written permission to conduct the study and use the school district's existing data.

Data Collection

The school district collected the data for both SNAP and FSA at the time of writing. The Ministry of Education collected the FSA achievement data and stored it on their SharePoint server for school districts to access. All Chilliwack students in the grade 7, 2019/20 cohort had their SNAP and FSA scores used in this study. The FSA data included grade 7 results for reading and numeracy. The SNAP performance data was entered into the Chilliwack School District's web-based data collection portal (ePAS) by classroom teachers and included grade 6 and 7 SNAP results – numeracy only.

The collected SNAP statistics contained similar information to FSA, including PEN numbers to ensure that student data is correctly correlated between datasets. A notable difference in the SNAP dataset is that it did not have a reading achievement measure, as SNAP is only a mathematics achievement measure. This study did not look at reading achievement as its focus but used reading achievement as an independent variable.

This study utilized listwise deletion to create final sample size numbers. There are roughly 1000 students in this cohort, and after excluding students who did not write either SNAP and FSA, the study has a sample size of 786 students. These students constitute all the students in the Chilliwack School District in grade 7 during the 2019/20 school year.

Achievement Data from SNAP & FSA

Students complete the numeracy component of FSA in two parts. There is a 30-question selected response component completed online and three written response questions completed in a booklet. The selected response questions count as one mark each, while each of the written response questions counts up to 4 marks, as scored on a four-point rubric. The maximum score a student can achieve is 42. The Ministry of Education then studies the results and creates cut scores to present student achievement. As per Table 3.2, *Emerging* (a score of 0-15), *On Track* (16-33), and *Extending* (34-42) are used to explain where students are in their learning continuum (BC Ministry of Education, n.d.). The Ministry of Education also creates a composite score for student achievement that considers other variables such as carryover data from previous FSA assessments to report student achievement more accurately in relation to other students from both the current cohort and previous cohorts. These scores generally range from the 300's (emerging) to over 600 (extending). The Ministry calculates the raw scores using an algorithm formulated from Item Response Theory (Mailman School of Public Health, n.d.), and the "scaled scores range from 200 to 800 with a mean of 500" (MacLeod & Emes, 2018, p. 4). For this study's purposes, the study uses the scaled scores (out of 800) in the data analysis.

Table 3.2 FSA Numeracy Scoring Grid

	Emerging	*On Track*	*Extending*
Raw Scores:	0 – 15	16 – 33	34 – 42
Scaled Scores:	200-399	400-602	603-800

The SNAP is a two-part assessment, each part a one-page written response question. One part focuses on number sense, and the second part focuses on a grade-appropriate operation. Each part has a score connected to a rubric. The number sense assessment connects to a three-point rubric (Figure 3.1), and the operations assessment uses a four-point rubric (Figure 3.2). The maximum score for the number sense SNAP is 12 (Table 3.3).

Table 3.3 SNAP Number Sense Scoring Grid

Beginning	*Developing*	*Applying*
0 – 6	7 – 10	11 – 12

The maximum score for the operations SNAP is 16 (Table 3.4).

Table 3.4 SNAP Operations Scoring Grid

Beginning	*Developing*	*Applying & Extending*
0 – 6	7 – 10	11 – 16

For this study, the SNAP assessment score is a combination of Operation and Number Sense, for a total maximum score of 28 (Table 3.5).

Table 3.5 SNAP Total Scoring Grid

Beginning	*Developing*	*Applying & Extending*
0 – 12	13 – 20	21 – 28

Figure 3.2 SNAP Number Sense Rubric

Chilliwack School District

Number Sense Rubric
SNAP (Student Numeracy Assessment & Practice)

Competency	1 *Student understanding and application of learning standard(s) is not evident*	2 *The student demonstrates some understanding and application of number sense*	3 *The student demonstrates proficient understanding and application of number sense*	*Teacher notes for demonstration of understanding and applications beyond proficiency*
Communicating and Representing *Picture Box*	• Pictures do not show the value of the number • Inaccurate	• Pictures show some value in representing the number • Partially accurate	• Pictures are clearly communicated and represent the value of the number • Accurate	
Describe Picture	• Description and elaboration of pictorial representation is not evident • Communication is not clear	• Partial accuracy in describing and elaborating on pictorial representation • Partially communicated	• Accurately describes and elaborates on pictorial representation • Clearly communicated	
Expanded Form	• The value of each digit is not evident	• Partially accurate in demonstrating the value of each digit	• Accurately demonstrates the value of each digit	
Understanding and Solving *3 Equations*	• Accurate grade appropriate operations are not evident	• Accurately uses grade appropriate operations in one or two equations	• Accurately uses grade appropriate operations in all three equations	
Connecting and Reflecting *Real Life Connection*	• A real life example is not provided	• A partial connection to a real life example is provided	• Connection to a real life example is provided • Demonstrates understanding of the number value	
Reflection	• Simple reflections on mathematical thinking are not evident	• Simple reflections on mathematical thinking are evident	• Some insight on mathematical thinking is evident	
Reasoning and Analyzing *Number Line*	• Incorrect estimate of placement of number on provided number line	• Partially correct estimate of placement of number on provided number line	• Correct estimate of placement of number on provided number line with benchmarks	
Counting Forwards and Backwards	• Incomplete and inaccurate	• Partially complete and accurate	• Complete and accurate	

Student Numeracy Assessment and Practice (SNAP)

Figure 3.3 SNAP Operations Rubric

Chilliwack School District

Operations Rubric
SNAP (Student Numeracy Assessment & Practice)

Competency	1 *Student understanding and application of number operations is not evident*	2 *The student demonstrates some understanding and application of number operations*	3 *The student demonstrates proficient understanding and application of number operations*	4 *The student demonstrates superior understanding and application of number operations.*
Communicating and Representing *Entire Assessment*	• Communication (written, pictorial or symbolic) of understanding is not evident	• Communicates (written, pictorial or symbolic) limited understanding	• Communicates (written, pictorial or symbolic) clear understanding in multiple ways	• Communicates (written, pictorial or symbolic) insightful understanding in multiple ways
Understanding and Solving *Draw & Calculate Boxes*	• Strategies to solve the problem and show understanding are not evident	• Strategies to correctly solve the problem and show understanding are simple or limited	• Uses ***grade appropriate*** strategies to correctly solve the problem and show understanding	• Uses multiple strategies ***(some beyond grade expectations)*** to correctly solve the problem and show understanding
Connecting and Reflecting *Real Life Example/ Word Problem*	• Real life example and connections to mathematical concepts are not evident	• Real life example and connections to mathematical concepts are limited	• Real life example and connections to mathematical concepts are evident	• Real life example and connections to mathematical concepts are insightful
Reflection	• Simple reflections on mathematical thinking are not evident	• Simple reflections on mathematical thinking are evident	• Some insight on mathematical thinking is evident	• Insightful reflection on mathematical thinking is evident
Reasoning and Analyzing *Estimate & Justify Box*	• Estimation/mental math strategies and justification are not evident	• Estimation/mental math strategies and justification are simple	• Estimation/mental math strategies and justification are reasonable	• Estimation/mental math strategies are reasonable and justification is detailed

Student Numeracy Assessment and Practice (SNAP)

The Number Sense SNAP uses a three-point rubric because the assessment does not provide students the opportunity to extend their thinking overtly. However, the Operations SNAP does provide extension opportunities. Due to these differences, there are two rubrics used for the SNAP assessment (Figures 3.1 & 3.2). These rubric criterion helps one understand the assessments' context, but the study will use the raw scores for SNAP and the FSA composite scores for comparing student achievement in SNAP to student achievement in FSA. The Operations SNAP has a maximum score of 16, and the maximum score for the Number Sense SNAP is 12, for a total score of 28 in this study.

Variables and Controls

The larger study has two dependent variables (as per Figure 3.1). One variable is the grade 7 Numeracy Foundational Skills Assessment achievement as measured as a scaled score out of 800 (MacLeod & Emes, 2018). The second dependent variable is the grade 6 SNAP achievement. However, to answer the first research question, *to what extent does SNAP achievement predict FSA achievement in mathematics for middle school students*; SNAP is the predictor (independent variable), and FSA is the outcome (dependent).

Independent Variables

The independent variables for this study include reading achievement, grade 6 letter grades, and self-perception of math efficacy. Further details on these variables are explained next.

Reading Achievement. The dataset includes student achievement information from students' 2019 reading FSA assessment. Students complete the reading part of the FSA either just prior to, or just after the numeracy part of the FSA. The FSA reading scoring system is like FSA numeracy. Scores are scaled and are reported from 200 – 800, with higher scores representing better achievement. The sample size for reading achievement in the study is 574 students.

Grade Six Letter Grades. The student letter grades from their grade six math classes are included in the study. This information was collected from report card data in the school district's student information system. Letter grades ranged from A's to F's. A numerical score was assigned to each letter grade.

Table 3.6 Letter Grade Coding

Letter Grade	*Code*	*n = 768*
A	6	
B	5	
C+	4	
C	3	
C-	2	
F	1	

Self-Perception of Math Efficacy. In addition to the FSA, students in grade seven complete another Ministry of Education data collection tool - the Student Learning Survey (SLS). Question #54 of the SLS asks a question relating directly to mathematics learning: *"I continue to get better at mathematics (for example, even if my problem-solving is already good, there is something else that is continuing to improve)."* For the purposes of this study, the student responses to that question have been used. Table 3.7 shows the coding for this question.

Table 3.7 Self Perception of Math Efficacy

"I continue to get better at mathematics."	*Code*	*n = 270*
Strongly Agree	5	
Agree	4	
Neither Agree or Disagree / Don't Know	3	
Disagree	2	
Strongly Disagree	1	

Control Variables

The control variables are extra data points that will explain some of the variances in the regression model. As we look at SNAP's predictive nature on FSA, these controls will help explain some of the reasons for greater or lesser connection. This section will explain gender, special education, ethnicity, and socio-economic status.

Gender. The demographic data has gender included. Female students are coded “0” and male students coded “1”. This factor will be a control measure.

Table 3.8 Gender Coding

Gender	*Code*	*n = 786*
Male	1	401
Female	0	385

Special Education Coding. Students with special education designations are included in the data set. Students with no special education designation are coded "0," and if there is a designation, those students will be coded "1".

Table 3.9 Special Education Coding

Variable	*Code*	*n = 786*
Special Education Designation	1	116
No Special Education Designation	0	670

Ethnicity. Demographic information on ethnicity is not widely collected in British Columbia, except for whether students are self-identified as having First Nations ancestry. Students without First Nations ancestry are coded "0," and with First Nations ancestry, they are coded "1".

Table 3.10 Indigenous Ancestry Coding

Ancestry	*Code*	*n = 786*
Indigenous	1	133
Non – Indigenous	0	653

Socio-economic Status (SES). Student demographic information included student postal codes. The postal codes correlate with a median income for each geographic area. (SES), was calculated by assigning a score to each student via their postal code. This assigning of a score to each student was done using the student postal codes and the affiliated mean household salary, provided by StatsCan. Based on the salary differentials, each neighborhood was given a numeric value to represent a social/economic score. The mean income number was used to create an SES factor. Table 3.8 shows how SES was coded. Each zone in the table respresents a postal code, with Zone 1 having the lowest SES average score of $52, 952 dollars.

Table 3.8 SES Coding

Postal Code Mean Household Income	*Code*	*n = 786*
Zone 6 - $100, 580	6	
Zone 5 - $90, 837	5	
Zone 4 - $75, 848	4	
Zone 3 - $57, 104	3	
Zone 2 - $53, 935	2	
Zone 1 - $52, 952	1	

Data Analysis

The analysis of data follows a logical progression that mirrors the research questions of this study. Question one asks, *does student achievement on grade 6 SNAP predict achievement on grade 7 numeracy FSA?* This analysis was completed through a Pearson correlation calculation. Question two asks, *do independent variables (reading achievement, classroom math achievement, and student self-perceptions of math efficacy) predict student achievement on SNAP and FSA?* This process was divided into two parts. Part one utilized a bi-variate correlation analysis using all three independent variables (reading, letter grades, and self perceptions of mathematics). Part two ultilized a multiple regression analysis, again with the same three independent variables. With each question, the study layered on more data points, creating richer and potentially more meaningful relationships. Question three pulls in the control variables by asking if control variables including gender, ethnicity, special education designation, and socio-economic status influence student achievement on SNAP and FSA when regressed alongside the independent variables. A multiple regression analysis was used to calculate these relationships as well. To effectively analyze the independent and control variables against the SNAP and FSA, it was important to ensure the coefficients used standard measures in this study. Therefore, beta weighting was used to allow for relative comparisons of each variable to each other for the regression analysis' for questions 2 and 3. Because question 1 was answered using a direct correlation calculation, the assigned correlation value is naturally standardized.

Validity and Reliability

There are several strategies that the study employed to ensure valid and reliable results.

1. The sample size is large. With 786 students involved in the study, many data points improve confidence in any statistically significant finding.
2. The data collection is done systematically - either through the Ministry of Education or through the School District's ePAS system.
3. The controls that are being implemented will assist in ensuring credible results.
4. The use of STATA will ensure that mathematical modeling will be accurate and replicable and minimize human error as much as possible.

Limitations

The study used data from 2019, with some of the data incomplete. For example, the main portion of the study (comparing SNAP and FSA directly), had 786 student samples. However, when reading achievement was considered, the cohort size dropped to 574 students. The smallest group in the study was connected to student self perceptions of mathematics, where the sample size was 286 students. Ideally, participation would have been higher, but the sample size of participants was still large enough to create statistically significant findings.

An additional limitation regarding the data collection of the study involved the human element involved in teacher grading student achievement. Scoring the SNAP required teachers to use their professional judgement when assigning a score. Teachers also graded a the written portion of the FSA and assigned the report card letter grades. Whereas these activities are all typical reporting and assessment procedures, there is room for the possibility of error, or at least some variance in scoring fidelity.

Conclusion

This chapter explained the processes and methods that were used in this study. The study's goal is to correlate student cohort achievement data between the SNAP 6 assessment outcomes and the FSA 7 assessment through a correlational analysis approach that includes a large sample size of cohort students (n=786). The study results show whether SNAP 6 student performance predicts student achievement on FSA 7 - numeracy. This chapter outlined the quantitative process that the study followed, and the validity and reliability strategies employed to ensure unbiased, accurate, and replicable results. As there are six other school districts in BC using the SNAP assessment and FSA, the methodology shared in this section should allow each of those districts to follow this study's process and compare results.

This chapter also explained how the data was collected, coded, and what types of data analysis tools were used. Chapter 4 will focus on the study results from the methods described.

CHAPTER FOUR: Results

This study examines the Student Numeracy Assessment & Practice (SNAP) predictive qualities relating to the Foundation Skills Assessment (FSA). Institutional achievement data from the Chilliwack School District in British Columbia, Canada serves as the data source for the study. The study used the data from 786 grade seven students who wrote both the SNAP and FSA assessments in 2019. There is one primary research question and two follow-up questions. Research question one asks, does student achievement on the grade six SNAP (Student Numeracy Assessment & Practice) predict achievement on the grade seven numeracy component of the FSA (Foundation Skills Assessment)? Question two delves deeper into the relationship between SNAP and FSA by asking how independent variables (reading achievement, classroom mathematics achievement, and student self-perceptions of mathematics efficacy) are related to student achievement on SNAP and FSA. The final and third research question asks, do control variables (gender, ethnicity, special education designation, and socio-economic status) predict student achievement on both SNAP and FSA? These three questions, considered in order, frame the study, triangulate the data sets, and help to give insight into similarities and differences between these assessments of the grade six mathematics curriculum.

Analysis Overview

As mentioned above, this study has three questions that will be answered in this chapter. Additionally, as shown in the conceptual model in Figure 4.1, this study has two dependent variables:

1. Grade 7 FSA numeracy achievement, and
2. Grade 6 SNAP achievement.

There are also three independent variables:

1. Reading Achievement, as measured by grade 7 FSA.

2. Mathematics Achievement, as measured by grade six report card letter grades.
3. Student perception of mathematics efficacy, as measured by the Ministry of Education Student Learning Survey.

Finally, there are four control variables included in the study: gender, socio-economic status, special education designation, and ethnicity.

The research questions use quantitative data sets and, through correlation, regression, and multi-regression calculations, the following pages will show and describe the findings.

Descriptive Analysis

The sample selection of data uses pre-existing institutional information from a cohort of students in grade 7 during the 2019/20 school year. The study includes all grade seven students in the Chilliwack School District who wrote both the SNAP assessment in grade six and the FSA (Numeracy) in grade 7. Students wrote both assessments in 2019. As Table 4.1 depicts, a total of 786 students represents the sample size. Just over half (51%) of the students were female. Approximately 17 percent of the students self-identified as Indigenous to Canada, and 116 students (or 14.8%) held special education designations.

Table 4.1 Background and Demographic Characteristics of Study Sample

Variable	*n*	Valid %
Sample Size	786	
Gender		
Female	385	49.0%
Male	401	51.0%
Racial Group[1]		
Indigenous	133	16.9%
Non-Indigenous	653	83.1%
Binary Grouping Special Education		
Special Education Designation	116	14.8%
No Special Education Designation	670	85.2%

[1]For racial group, participants self-identified.

Table 4.2 provides an overview of how the sample population performed on the grade seven FSA (Numeracy). There were 786 who wrote the assessment, and the average student score was 450.53 on a scale between 200-800 points. A scaled score of 450 places a student “On Track” based on the scoring rubric from the BC Ministry of Education. See table 3.2 from (Chapter Three) for further details on the FSA numeracy scoring grid. The student scores ranged from a low score of 236 to a high score of 756.

Table 4.2 Descriptive Statistics (FSA)

Variable	
FSA	
Observations	786
Mean	450.53
Median	445
Range	236 - 756

Table 4.3 shows a similar breakdown of student performance on the grade six SNAP assessment. The same 786 students wrote the assessment, and the average student score was 20.38, on a scale between 0 – 28 points. A score of 20 places a student’s achievement at the upper end of “Developing” and very near “Applying” on the SNAP proficiency scoring grid. Table 3.5 (Chapter 3) provides further detail. The student scores ranged from a low score of 5 to a high score of 28.

Table 4.3 Descriptive Statistics (SNAP)

Variable	
SNAP	
Observations	786
Mean	20.38
Median	22
Range	5 - 28

Both assessments (Grade 6 SNAP and FSA Numeracy 7) claim to assess the grade 6 British Columbia mathematics curriculum – as explained in Chapter 2. Research questions 1-3 will provide further details on the connectedness between these assessments and how they appear to connect to and align with the curriculum.

Analysis 1 - Research Question 1. *Does student achievement on the grade 6 SNAP predict achievement on the grade 7 numeracy FSA?* Question one was answered through a Pearson correlation. In this case, the test showed (as per Table 4.4) a .60 correlation (R-value) between SNAP six and FSA seven. The correlation is moderately strong, positive, and significant, with a p-value of less than 0.001. There are 786 students included in this calculation.

Table 4.4 Pearson Correlations for FSA & SNAP

Variable	*r*	*p*	*n*
FSA			
SNAP	.60***	.001	786

***p<.001
**p<.01
*p<.05

A regression calculation was also run, showing an adjusted R^2 value of .36. Based on this information, SNAP achievement predicts a moderate positive relationship to FSA achievement. SNAP achievement also accounts for 36% of the variances between the two assessments – a low to moderate relationship.

Analysis 2 - Research Question 2. *Do independent variables (reading achievement, classroom mathematics achievement, and student self-perceptions of mathematics efficacy) predict student achievement on FSA and SNAP?* The process was divided into two parts – a correlation analysis and a regression analysis to answer this question. The explanation of the findings for each part is below.

Bi-Variate Correlation Analysis. Each independent variable was correlated with both SNAP and FSA. Figure 4.5 shows the correlations between FSA – Reading, FSA – Mathematics Letter Grades, and FSA – Self Perceptions of Mathematics. The relationship between FSA and Reading showed a .53 correlation with a significant p-value of less than .001. The sample size for this relationship was 574 students because not all the students who wrote the numeracy portion of the FSA wrote the reading portion. The relationship between FSA and Mathematics

Letter Grades showed a .64 correlation with a significant p-value less than .001. The sample size included almost all the students in the study, as 767 students had recorded letter grades in the data set. Finally, the relationship between FSA and Self Perceptions of Mathematics showed a .23 correlation. This correlation was lower than the other relationships but was still highly significant with a p-value of less than .001.

Table 4.5 Pearson Correlations for FSA & Independent Variables (IV)

Variable	*r*	*p*	*n*
FSA			
Reading (FSA)	.53***	.0001	574
Mathematics Letter Grades	.64***	.0001	767
Self-Perception of Mathematics	.23***	.0001	270

***p<.001
**p<.01
*p<.05

The exact process was completed for SNAP relationships with each independent variable, as shown in Table 4.6.

Table 4.6 Pearson Correlations for FSA & Independent Variables (IV)

Variable	*r*	*p*	*n*
SNAP			
Reading (FSA)	.42***	.0001	574
Mathematics Letter Grades	.64***	.0001	767
Self-Perception of Mathematics	.24***	.0001	270

***p<.001
**p<.01
*p<.05

The relationship between SNAP and Reading showed a .42 correlation, with a significant p-value less than .001. Both SNAP and FSA had a moderate correlation, with FSA showing a slightly stronger relationship in this analysis. The sample size was 574, the same as FSA – Reading. The correlation between SNAP and Mathematics Letter Grades was the same as the FSA – Mathematics Letter Grade: .64. Again, the finding was significant, and the sample size was the same, at 767 students. The relationship between SNAP and Self-Perception of Mathematics showed a .24 correlation with a highly significant p-value less than .001. This correlation was a little higher than the FSA relationship (.23) but similar.

Bi-Variate Relationship Between FSA and SNAP. Two regression analyses were completed, looking for:

1. The interplay between FSA, reading achievement, mathematics letter grades, and student perceptions of mathematics efficacy, and,
2. The interplay between SNAP, reading achievement, mathematics letter grades, and student perceptions of mathematics efficacy.

By studying the relationship between the independent variables and the dependant variables on each of the assessments on their own, the effect of individual variables can be quantified.

Table 4.7 shows the multiple regression between FSA Numeracy and the independent variables. For this regression model, beta weights (standardized coefficients) were used to ensure that the relationships displayed are as accurate as possible. The adjusted R^2 value is .44, representing forty percent of the variance in FSA achievement. The sample size for this calculation dropped to 194 students as not as many students completed all three assessments.

Table 4.7 Multiple Regression (FSA/IV)

Variable	*β*	*p*
FSA Numeracy (DV)		
Reading FSA	.31***	.0001
Mathematics Letter Grades	.46***	.0001
Self-Perception of Mathematics	-.01	.879

***p<.001
**p<.01
*p<.05

Table 4.7 shows that reading achievement has a moderate and significant effect on FSA numeracy achievement – a beta weight of .31 and a p-value of less than .001. Mathematics letter grades are the best predictor of FSA achievement with a high beta weight of .46 with a significant p-value. However, self-perceptions of mathematics, while significant in the bivariate correlation analysis, is not significant with the other variables included in the regression.

Looking at the regression model that incorporates SNAP and the independent variables, the findings start to shift when compared to the bivariate analysis (Table 4.6 vs. Table 4.8). For instance, the effect on reading – an effect that previously showed a significant moderate correlation (in the bivariate calculation), has now dropped to a very weak (.10) beta weight with no statistical significance (p-value of .12). Additionally, mathematics letter grades have increased in effect size to .61 with a statistically significant p-value of .001. Self-perceptions of mathematics no longer have a statistical impact on SNAP with a beta weight of .02 and a p-value of .730. The adjusted R^2 value for Table 4.8 is .47.

Table 4.8 Multiple Regression (SNAP & Ind. Variables)

Variable	*β*	*p*
SNAP (DV)		
Reading FSA	.10	.12
Mathematics Letter Grades	.61***	.000
Self-Perception of Mathematics	.02	.730

***p<.001
**p<.01
*p<.05

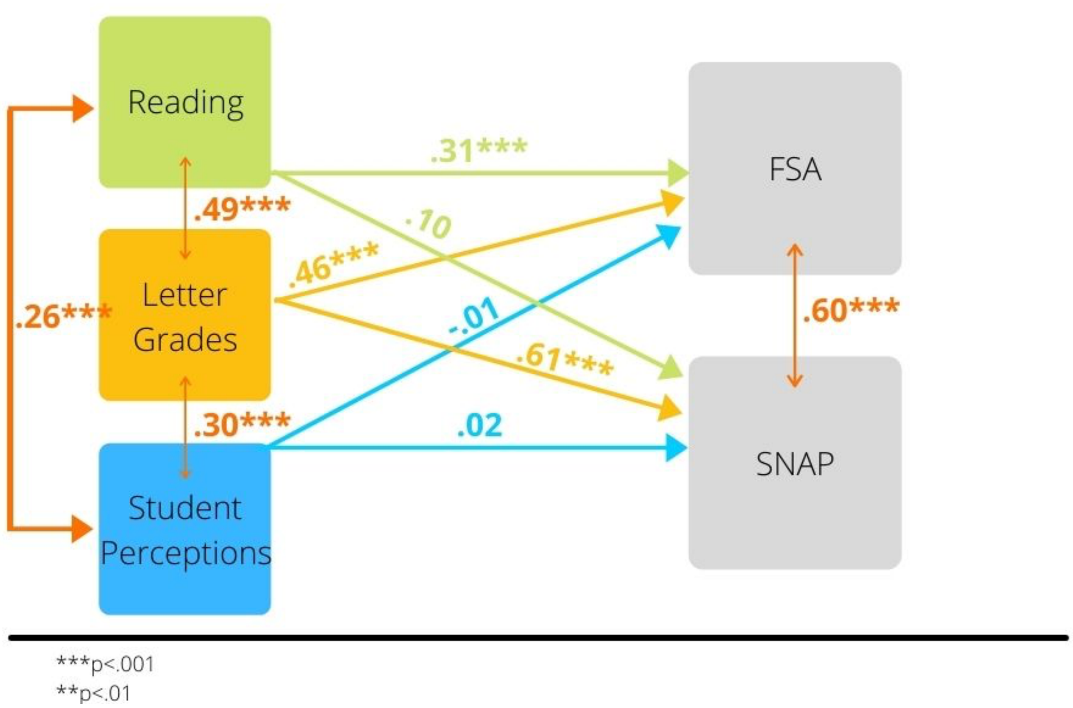
As shown in Tables 4.7 and 4.8, these regression models begin to show some marked differences between SNAP and FSA numeracy. Both assessments are still correlated with mathematics letter grades, but that is where the similarities end. Reading achievement influences FSA numeracy but there is no effect on SNAP. Self-perceptions of mathematics have no effect on FSA or SNAP.

Conceptual Model of FSA, SNAP, and Independent Variables. Figure 4.2 shows the conceptual model, complete with beta weights for each relationship. The three independent variables are represented in the model – reading achievement, mathematics letter grades, and student perceptions of mathematics efficacy. The beta weighting used in this model ensures that the dependent and independent variables are compared using standardized coefficients – meaning that the correlation weighting allows for an ‘apples to apples’ comparison – even though the variables each have different original datasets. There are three very important relationships shown in this model:

1. This model represents the core question in the study – does SNAP achievement predict achievement on the FSA? That relationship is shown in the model with a .6 significant correlation.
2. The center of the model depicts the triangulation of FSA, SNAP, and mathematics letter grades – providing evidence that all three variables are highly inter-related.
3. The relationship between reading achievement and the two numeracy assessments is shown in this model. Reading achievement has a significant, moderate effect on FSA, and no effect on SNAP.

Figure 4.1 Conceptual Framework with Statistics

Note: Two-headed arrows represent direct correlations. One-headed arrows represent multiple regression relationships. All estimates are from models using standardized scores (Tables 4.7 and 4.8).



Analysis 3 - Research Question 3. *Do control variables such as gender, ethnicity, special education designation, and socio-economic status influence student achievement on FSA and SNAP?* The previous regression models (Tables 4.7 & 4.8) were expanded upon by adding four control variables to answer question three. Table 4.9 is the enhanced FSA regression model, complete with controls for gender, ethnicity, special education designation, and socio-economic status. The adjusted R^2 value increased slightly to .47. With the control demographics added to the equation, reading beta weights increased from .31 to .36, and the beta weights for mathematics letter grades stayed the same at .46. Ethnicity, special education designation, and socio-economic status did not show any stand-alone relationship, however, gender did. Gender came through with a highly significant p-value of .001 and a weak beta weight of .20, meaning that boys did significantly better on FSA than girls.

Table 4.9 Multiple Regression (FSA with Independent & Control Variables)

Variable	β	p
FSA Numeracy		
Reading (FSA)	.36***	.000
Mathematics Letter Grades	.46***	.000
Self-Perception of Mathematics	-.04	.468
Gender (Control)	.20***	.000
Ethnicity (Control)	-.04	.513
Special Education (Control)	-.01	.912
Socio-Economic (Control)	-.05	.403

***p<.001
**p<.01
*p<.05

Table 4.10 features the same regression calculations as Table 4.9, but with SNAP as the dependent variable instead of FSA numeracy. The adjusted R^2 value dropped slightly, compared to the model without demographics, accounting for .46 of the variances in SNAP. Reading achievement continues to be insignificant, as do perceptions of mathematics, and all of the controls, except for ethnicity. Perceptions of mathematics, previously insignificant in the regression analysis without control variables (see Table 4.8), remains so with the additions of the control variables. Mathematics letter grades remain a lone strong standout in this regression analysis with a beta weight score of .57 and a p-value of less than .0001. Ethnicity shows as a significant control variable with a p-value of .001 and a beta weight of -.19, meaning that students with Indigenous ancestry exhibited slightly lower achievement than students without.

Table 4.10 Multiple Regression (SNAP & Ind./Control Variables)

Variable	β	p
SNAP		
Reading (FSA)	.11	.096
Mathematics Letter Grades	.57***	.000
Self-Perception of Mathematics	.01	.935
Gender (Control)	-.01	.893
Ethnicity (Control)	-.19***	.001
Special Education (Control)	-.05	.385
Socio-Economic (Control)	-.01	.856

***p<.001
**p<.01
*p<.05

Table 4.11 depicts the changes in adjustd R^2 values as the models progressed in this study. The first regressional modelling factored in the dependent and independent variables only with R^2 values of .44 (FSA) and .47 (SNAP). The final modelling introduced the control variables to the independent variables in the regression calcuations. These calculations had R^2 values of .47 (FSA) and .46 (SNAP) respectively.

Table 4.11 Change in R^2 Value in Model Progression

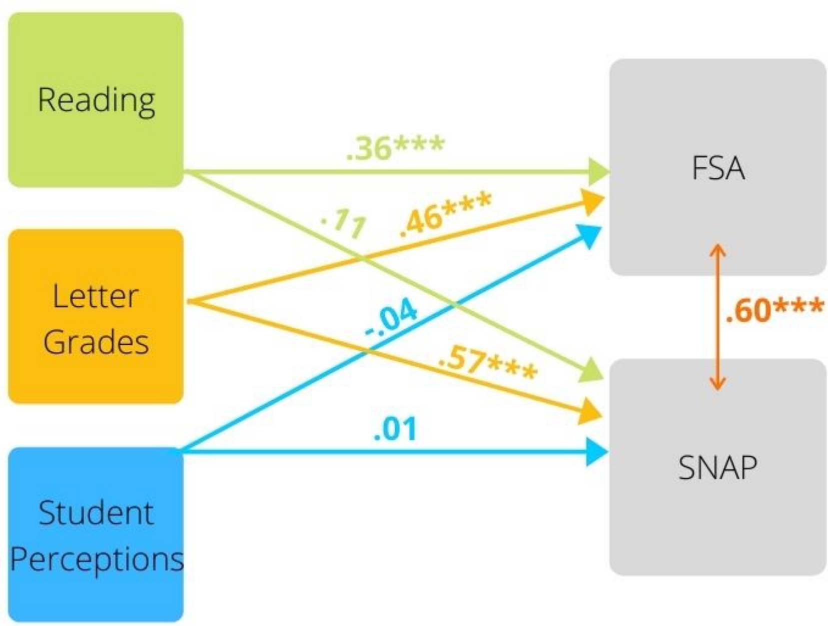
Adjustd R^2 Value	R^2
Model Progression	
Table 4.7 (FSA Figure 4.1)	.44
Table 4.8 (SNAP Figure 4.1)	.47
Table 4.9 (FSA Figure 4.2)	.47
Table 4.10 (SNAP Figure 4.2)	.46

Conceptual Model of FSA, SNAP, Independent, and Control Variables

Figure 4.2 shows the influence of the control variables on the adjusted beta weights for the regression model in visual form. This model mirrors the progression of the research study by adding to Figure 4.1 the effects of control variables. The effect of the control variables can be seen with slight adjustments throughout the model. Examples include reading achievement effect on FSA increases from .31 to .36 and letter grade effect on SNAP falls slightly from .61 to .57. Student perceptions of math efficacy continued with no significance when correlated to SNAP or FSA as controls were introduced to the model. Most importantly however, this modelling shows similar findings to the previous models.

Figure 4.2 Conceptual Framework with Controls & Adjusted Beta Weights

Note: Two-headed arrows represent direct correlations. One-headed arrows represent multiple regression relationships. All estimates are from models using standardized scores (Tables 4.9 and 4.10).



***p<.001
**p<.01
*p<.05

Summary

This chapter discussed the results of the quantitative analyses conducted for this research study, provided descriptive statistics regarding the sample population used in the study, and presented the results of independent correlations and multiple regressions to determine statistically significant similarities and differences between SNAP and FSA (Numeracy). Results indicated a significant moderate direct correlation between SNAP and FSA (Numeracy). Regression analyses suggest a moderate positive correlation between both SNAP and FSA and grade six mathematics letter grades. However, similarities between SNAP and FSA end there. Reading achievement correlations strengthen concerning FSA (Numeracy) as controls were added.

In contrast, reading achievement correlations weaken to the point of insignificance when regressed on SNAP with controls added. Student self-perceptions of mathematics started with some potential significance in the study, but as controls were added, the analysis showed insignificant results. The following chapter will discuss the research findings in greater depth.

CHAPTER FIVE

Overview

This study explores the relationships between the Student Numeracy Assessment and Practice (SNAP) and the Foundation Skills Assessment (FSA) (dependent variables) and reading achievement, mathematics letter grades, and student perceptions of mathematics efficacy (independent variables). Using a conceptual framework (Figure 5.1), a mix of correlation and multiple regression analyses, and additional control variables, the study revealed compelling findings that add value to the numeracy assessment research body by validating SNAP as an assessment of numeracy that does not have a significant correlation to reading proficiency. These results might prove useful to educators, especially those in British Columbia. This chapter discusses the study results, identifies practical implications, reviews limitations, and provides suggestions for future research.

Discussion of Findings

This study found statistically significant positive correlations between SNAP and FSA but also highlighted significant differences too. The study found that the numeracy portion of the FSA had a moderate positive correlation with SNAP. On the one hand, this is not surprising as both assessments claim to assess aspects of the grade 6 mathematics curriculum. Additionally, both SNAP and FSA had positive correlations to grade six mathematics letter grade achievement, connecting both assessments in practical classroom practice. This connection to letter grade achievement in grade six mathematics supports a validation of SNAP (and FSA as well). Classroom teachers have shown that their assessment practices are valid, even as valid as standardized testing (Rimfeld et al., 2019). The students from this study represent the collective total of thirty classroom teachers, providing assessment information that is highly correlated to both SNAP and FSA.

A significant difference between this study and prior research is how reading achievement predicts numeracy achievement on both FSA and SNAP. Specifically, prior research suggests that reading achievement is a strong predictor of numeracy achievement (Björn et al., 2008; Grimm, 2008). In this study, reading achievement did have a significant positive correlation to FSA numeracy achievement. However, reading achievement was not correlated with SNAP achievement. While statistically similar in some ways, SNAP and FSA are very different in how reading proficiency predicts student achievement on each of these numeracy measures. This finding is remarkable and will be discussed in further detail later in this chapter.

The Relationship Between SNAP and FSA

The core question in this research asked, does student achievement on grade six SNAP predict student achievement on grade seven FSA? The correlation between SNAP and FSA is moderately strong and significant – providing evidence that SNAP does predict FSA achievement. However, correlation does not prove causation, and we need to dig deeper into the data and the methodology of the study to provide more answers. On one hand, this study shows that a mathematics assessment that focuses on the mathematical understanding of competencies strongly correlates to a more traditional mathematics assessment is a significant finding. SNAP is an assessment that focuses on two mathematical content areas in a deep fashion by assessing curricular competencies. Student achievement on SNAP positively correlates to the FSA – an assessment that attempts to incorporate all content areas of the mathematics curriculum in one test. While this study established that SNAP and FSA are correlated, there is clearly more to the story. A discussion of how the independent variables relate to student achievement on both assessments will provide more insight in the next section.

SNAP/FSA Relationship to Letter Grades, Reading, and Self Perceptions

This study revealed several interesting findings related to the independent variables (reading achievement, mathematics letter grades, and student perception of mathematics efficacy) and their connection to both the SNAP and FSA.

Mathematics Letter Grades. The relationship between SNAP achievement, FSA achievement, and mathematics letter grades is crucial for this study. When analyzed together, these different ways to assess for mathematics achievement create triangulation, assisting with increased validity for both assessments. Both SNAP and FSA had a moderately strong and significant correlation to mathematics letter grades for students in this study. This finding is important because these correlations validate both SNAP and FSA as assessments of the mathematics curriculum. Teacher professional judgment over a full year of teaching, learning, and assessing is a valid assessment of student achievement (Rimfeld et al., 2019). SNAP and FSA both assert that they are assessments of the mathematics curriculum. This finding supports that assertion.

Reading Achievement. Perhaps the most exciting finding in this study is the effect of the independent variable 'reading achievement' on SNAP and FSA. As numerous studies show, reading achievement is highly correlated as a predictor of mathematical proficiency (Björn et al., 2008; Grimm, 2008). Therefore, the finding that reading achievement is predictive of FSA achievement is not surprising. Students who are strong readers do well on FSA – and vice versa. However, the reading/SNAP relationship is not the same. Reading achievement was not a significant predictor of SNAP. This lack of predictive relationship between reading and SNAP is an important finding because reading achievement almost always is significantly related to numeracy achievement (Björn et al., 2008; Grimm, 2008). However, in SNAP, it does not. Based on the construction of SNAP and FSA and how students interact with each assessment, there are two compelling explanations and one alternative:

1. FSA is a text-heavy assessment. Students need to read the 30 selected-response questions and possible answers (BC Ministry of Education, n.d.-a). Students also need to read the three short answer questions before they can solve them. Reading in this manner requires students to decode the text, create meaning from the words, find the big idea from the question, and synthesize the text into the mathematical question. They then must solve the question. The FSA requires students to be proficient readers to engage with the numeracy assessment. Students who struggle to read are likely to suffer from anxiety, and anxiety can have a large impact on student achievement in mathematics (Finlayson, 2014). It makes sense that reading achievement would align with numeracy achievement.
2. SNAP is not a text-heavy assessment. There is very little reading required at all. Students begin with a mathematical equation, number, or expression and use their prior knowledge and contexts to answer the questions in their primary language (Chilliwack School District, 2016). Students must communicate their thinking through diagrams, calculations, and written words, but they do not need to read for understanding to complete the SNAP successfully.
3. An alternative, and perhaps liberal analysis of the relationship between reading achievement and mathematics assessment connects back to Chapter Two. Research was presented that showcased the alignment of thinking competencies between mathematics and literacy (Draper, 2002; Roepke & Gallagher, 2015; Zollman, 2009). Perhaps a reading assessment that was more focused on the thinking competencies of reading (and less on decoding text) would be correlated to the SNAP mathematics assessment. If this

were the case, then it might be reasonable that an assessment of reading could be better correlated to SNAP – the opposite of the current reality.

A mathematics assessment that does not require students to be proficient readers but still assesses mathematical processes and competencies is an important finding that can have implications in both the classroom and at the policy level. For example, students who stuggle to read or write in English (i.e., second language speakers, students with learning disabilities, etc.) may have difficulty accessing a traditional mathematics assessment. This study suggests that SNAP could provide a equitable alternative to traditional, language laden mathematics assessments because language proficiency is not a barrier for students in taking the SNAP. Students can show how they apply their strategies, thinking, and reasoning skills to mathematical situations without having to comprehend written language first. This finding suggests that there is a value in using SNAP over a more text-heavy assessment like FSA as the former may be a better predictor of mathematics skills rather than a test of reading.

Mathematics Efficacy. The findings in this study connected to students' self-assessment of mathematics efficacy show that they were not statistically related to SNAP or FSA. This lack of connection is an unexpected finding because the research points to strong correlations between student self-efficacy in mathematics and achievement (Chen, 2003; Parker et al., 2014). A possible explanation for this finding could be connected to the methodology of this study. There was a correlation to mathematics efficacy in the early stages of the study that disappeared later when control and other variables were added to the equation. Specifically, when correlated directly to achievement on SNAP and FSA, mathematics efficacy was significant, which aligns with prior research (Chen, 2003; Parker et al., 2014). However, as independent and control variables were added to the regression model, the significance of mathematics efficacy disappeared. This means that in the present study, the other variables when regressed alongside mathematics efficacy drew significance from efficacy. A possible reason for the low effect of math efficacy on student achievement in mathematics could be explained by classroom practice of metacognitive skills. We know the importance of teaching these strategies explicitly (Hattie, 2009; Ozsoy and Ataman, 2009, 2011; Thomas, 2006), and that they are taught alongside SNAP use (Chilliwack School District, 2016). This teaching could have produced the early correlation (prior to introducing control variables) between math efficacy and SNAP. However, from my experience in the BC school system, teaching reflective thinking skills is a relatively new approach for teachers, and it could be argued that neither teachers or students are skilled in this competency yet.

Impact of Gender, Special Education, Ethnicity, and Socio-Economic Status

The control variables for this study included gender, special education designation, social-economic status, and ethnicity. Fifty-one percent of the 786 grade seven students were male, and forty-nine percent were female. Gender was not significantly related to SNAP achievement but showed a slight positive correlation to males, meaning that boys did slightly better on average than girls on the FSA. Interestingly, SNAP showed no gender effect, and FSA did, and this study cannot explain that difference. Other research studies (Llyod, Walsh, & Yailagh, 2005; Voyer & Voyer, 2014) support the likelihood that girls do better on reading exams, and boys tend to perform better on mathematics tests, but that trend does not play out in this study. The mathematics exam that requires more reading (the FSA) is the one where boys outperformed girls. The mathematics assessment that does not require reading (SNAP) revealed no achievement effect from either gender. The impact of gender on SNAP student achievement is area that deserves future study and may be useful in creating more gender equity in mathematics.

There were 14.8 percent of students with a special education designation in this study. In examining the effect of special education designation on the study, the results show no relationship to either SNAP or FSA. This finding is surprising, as previous data suggest that the performance of students with special education designations usually reveals lower achievement on academic assessments (BC Ministry of Education, 2020). Possible reasons for this finding are that students with special education needs had accommodations supplied to ensure that they could perform to their potential on the assessment. For instance, a student who struggles with written output or decoding words (reading) may have had access to a scribe or a reader.

Nearly seventeen percent (16.9%) of students in the study had Indigenous ancestry. Indigenous ancestry was not related to FSA results; however, there was a small negative relationship to SNAP performance. Students with Indigenous ancestry performed worse on SNAP than their non-Indigenous classmates. This finding is surprising because one might anticipate that due to the open nature of SNAP, barriers would not exist for ethnicity, culture, and background, potentially providing a positive effect on student performance. This line of thinking is congruent with previous research (Zevenbergen et al., 2008) yet did not play out in this study. As with gender, this is an area worthy of further exploration.

When controlling for socioeconomic status, the impact on student achievement had no direct relationship to either SNAP and FSA. This finding is interesting, as research shows that students with higher socioeconomic status tend to achieve better on mathematics assessments (Sirin, 2005).

Limitations of the Study

This study was limited to the correlations between SNAP, FSA, and various independent and control variables. These relationships showcased the correlations between the variables but do not reveal anything about causation. For instance, this study shows that SNAP achievement has a moderately strong correlation to FSA achievement, but it does not reveal whether better SNAP achievement causes improved FSA achievement.

A second limitation includes the timing of the collection of data. All data were collected in 2019, meaning that the data was already two years old at the time of the study. Additionally, not all students completed the Student Learning Survey. Ideally, all students would have completed it, but only 270 out of the 786 students completed the survey, potentially limiting the findings.

Finally, the scoring of the SNAP and the process of assigning letter grades is an autonomous teacher activity where there is an opportunity for professional judgment and potential error. For instance, the Ministry of Education has a process for ensuring that FSA teacher markers (for the short answer questions) have adequate training to grade the student responses as well as an auditing process using samples of graded papers (Oliveri, Gunderson-Bryden & Ercikan, 2012). In contrast, the school district does not have checks and balances in place for SNAP scoring or report card letter grades, and so grading fidelity could be impacted. It is not unusual for school districts to lack a rigorous process, and it should be noted as a potential limitation of the study.

Implications for Practice

As mentioned in Chapter One, the FSA has received public criticism from the teacher's union in British Columbia, stating that the assessment is not an effective measure of student achievement (BCTF, 2021). This study has validated the 'system check' prowess of FSA by correlating FSA achievement with letter grades on student report cards and SNAP alignment, but it has also offered a potential alternative. SNAP, or a similar assessment, could provide comparable levels of system accountability while also providing a tool that classroom teachers can use as an assessment ‘for, of, and as' learning. Educators looking for alignment with competency-based curriculums could utilize a SNAP-based assessment that works in the classroom as an assessment to drive student learning for teachers and in the board room as system-level accountability for policymakers.

There is a potentially attractive second alternative to 'swapping out' one assessment for the other – an FSA/SNAP hybrid. A revision to the FSA where the three short response questions are replaced with the SNAP could provide a wholistic assessment of the mathematics curriculum. The content of the curriculum would be assessed via the 30 selected-response questions and the curricular competencies would be addressed by the two SNAP open-ended assessments. This approach could provide a balanced approach to assess both traditional content and progressive competency learning outcomes.

An additional implication includes how students who have difficulty with language are assessed in mathematics. For instance, using SNAP (or a similar approach) might help students with learning disabilities in reading, low reading scores, or who speak a foreign language. Students who struggle with language and have difficulty accessing tradional, literacy based mathematics assessments, might find fewer barriers with SNAP use. SNAP assessment use might provide a more accurate demonstration of their skills and knowledge in mathematics when compared to FSA (or similar). This finding raises a potential cautionary flag regarding the use of FSA to measure student achievement in mathematics, and poses an equity question. This research study suggests that student achievement in the numeracy component of FSA might only be accurate for students who are already proficient in reading. Does it make educational sense for an assessment of numeracy to require reading skills to complete it?

Questions for Further Research

The findings from this study set the stage for further research. Because this study found that student achievement in mathematics using SNAP was not related to student reading achievement levels, a logical next study would be to compare sample populations of students in their mathematics proficiency. A study comparing SNAP achievement and FSA (or similar) could help answer new questions. For instance, do ESL (English Second Language) students perform better on SNAP? A similar question might be, do students with low reading levels and learning disabilities in reading perform better on SNAP?

As mentioned earlier in this chapter, the relationships between gender, ethnicity and SNAP/FSA deserve further research. The findings from this study provided interesting results that point to unanswered questions.

An additional area for further study would be to replicate this study in another district. Even though this study had a large sample size (786 students), it would be good to repeat this study elsewhere to compare the results from the two studies.

Finally, chapter Two explained that assessing through competency-based methods aligns with best teaching practices. The SNAP is an assessment “for, of, and as” learning (Stiggins, 2002, 2014) – a rare and potentially game changing approach to mathematics instruction. A study that focused on the achievement of students who are taught and assessed regularly using SNAP compared to a sample of students taught in a traditional mathematics classroom might yield interesting findings to further mathematics educational practice.

Conclusion

This study explored the relationships between the Student Numeracy Assessment and Practice and the Foundation Skills Assessment. Using a conceptual framework (Figure 4.1), a mix of correlation and multiple regression analyses, and additional control variables, the study revealed compelling findings that add value to the numeracy assessment research body. A key finding included validating the SNAP assessment as an assessment of numeracy proficiency. Secondly, and potentially more significantly – the SNAP was found to be an assessment of numeracy, free of the influence of reading proficiency. In this study, reading achievement did have an impact on a traditional, commonly used numeracy assessment, FSA; but reading achievement had no influence on student achievement of SNAP.

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