Utilizing Assessment Resources to Support Classroom Instruction in Mathematics

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A capstone project submitted in partial fulfillment

of the requirements for the degree of the

Doctorate of Education

in Educational Leadership

University of Washington Tacoma

2016

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Program Authorized to Offer Degree: University of Washington Tacoma Education Program

Dedication

I dedicate this work to my wonderful family who has supported me for many years. First to my mom, you have been my greatest inspiration. You have helped me to believe that I am capable of accomplishing anything and have taught me that God provides a way for us to make it through any situation. You have truly instilled within me the value of education. As you have always said, “Education is something that cannot be taken away.”

To my beautiful daughter Juliet, you are my greatest gift and love. Proud is an understatement of how I feel about you. Thank you for being my partner and best friend. I cannot imagine my life without you. To Gordon, an amazing friend, thank you for your constant encouragement and support and for having the ability to bring in that unique perspective. You truly display God’s love. And to my little Jayden, who was my gift six months into my program. You are my joy and light.

Acknowledgements

I would like to thank the University of Washington Tacoma faculty for both bringing this program to the campus and for your amazing encouragement throughout. In particular, Christopher Knaus who has taken the time to get to know his students. Thank you for your care in helping us to define and achieve our goals. It has been a privilege to have been on the receiving end of the dedication you have to your students.

To Ginger MacDonald, you are an inspiration. Your calm spirit and clear direction has helped to give me peace during this very demanding time. I have truly appreciated your constant belief in us. To Jim Hager, you came to the program at a time when your competence, experience, and flexibility was much needed. I am so thankful to have had you as my chair, you have been a great match for my needs. Thank you also for your encouragement and support in my next steps.

To Robin Munson and Jennifer Quinn, thank you for your willingness to support me in this endeavor. Robin, I appreciated the insight and background that brought in your reviews from the perspective of the Office of Superintendent of Public Instruction (OSPI). It has been a pleasure to serve with you in the agency.

To my colleagues at the OSPI, Anton Jackson, Julie Wagner, and Tracy Godat. I could not have done this without you. You were my sounding boards and true partners in creating the resources for this project. And you are my friends. Thank you so much for being there, supporting and encouraging along the way. I could not have asked for a better team.

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Executive Summary

Mathematics teachers in the state of Washington have the responsibility of helping students develop the knowledge and skills included in the Mathematics K-12 Learning Standards (also known as the Common Core State Standards for Mathematics) and measured by the Smarter Balanced summative assessments in mathematics. A great need existed for teachers to have additional support to help students learn the standards and be prepared to demonstrate their knowledge on the Smarter Balanced assessments as well as more working knowledge of how to utilize the supports provided within the system of Smarter Balanced. Mathematics educators in the state of Washington were surveyed at the end of the 2015 school year for the purpose of gathering information on awareness and use of available Smarter Balanced assessment resources and to recommend additional resources, support, and best ways to communicate to the field about the resources. As a result of the teacher feedback, the mathematics assessment department at the Washington State Office of Superintendent of Public Instruction (OSPI) developed resource and support documents to supplement those available from Smarter Balanced. The website location where the documents were uploaded was redesigned to highlight the resources, for easier navigation, and better access by grade level.

Key words: Mathematics, Smarter Balanced, Assessment, Resources

CHAPTER 1

STANDARDS AND ASSESSMENT

The Washington State K-12 Learning Standards, formerly known as the Common Core State Standards (the Standards), were adopted in 2011 by the state of Washington. One of the goals of the Common Core was to establish a set of standards that was consistent in content and rigor across the states. Another aim was to ensure that students were learning the necessary skills to prepare them for a global economy (Ready Washington Coalition, n.d.). The Washington State Office of Superintendent of Public Instruction (OSPI) worked together with districts, schools and teachers over a three-year period to transition classrooms across the state into full implementation of the standards by the 2013-2014 school year. During the spring of 2015, students took the new assessments, provided to the state by the Smarter Balanced Assessment Consortium. The two instruments, one in mathematics and one in English language arts (ELA), were aligned to the Washington State K-12 Learning Standards and designed to be a better measure of what students know and understand (Ready Washington Coalition, n.d.). This applied capstone project focused on the mathematics portion of the Smarter Balanced Assessments.

Statement of the Problem

Mathematics teachers in the state of Washington have the responsibility of helping students develop the knowledge and skills included in the Mathematics K-12 Learning Standards, measured by the Smarter Balanced summative assessments in mathematics. Preparing students to take the assessment on a new set of standards and using an on-line format presented a challenging task (Rentner, Kober & Center on Education Policy, 2014). The mathematics assessment department at OSPI has conducted trainings and committee meetings throughout the state. When teachers attended these trainings and meetings, they could both formerly (in evaluation surveys) and informally (during casual conversations) share the needs of teachers from their schools and districts with OSPI personnel. This information was then discussed internally at OSPI by the agency mathematics team, made up of teaching and learning, assessment, special education and Title I mathematics staff. Next steps were then discussed on how to address the needs of the mathematics teachers in the state.

During these discussions, it came to the attention of OSPI staff that there was a great need for teachers to have additional support to help students learn the standards and be prepared to demonstrate their knowledge on the Smarter Balanced assessments, and for teachers to have more working knowledge of how to utilize the supports provided within the system of Smarter Balanced. Because a support was available did not ensure that it was helpful for improving or adjusting instruction or for preparing students for the assessments if teachers were unsure or unaware of how to access or use the resource to support classroom instruction. As a result of this initial feedback from teachers, OSPI personnel determined that it would be helpful to gather further information from the teachers on the topics of support and resources. A survey was sent out to mathematics teachers in the state of Washington at the end of the 2015 school year for the purpose of gathering this information.

Justification

Federal law requires that students in grades 3–8 and high school be tested annually in mathematics and ELA for federal reporting and accountability purposes (U.S. Department of Education, 2015; Cafazzo, 2015; McDonnell, 2013). The Smarter Balanced summative assessments that are administered to the students in the State of Washington during the spring of each year, beginning in 2015, fulfill this purpose. These summative tests are intended to ensure a quality education for all children by providing data to inform teaching and learning, program improvement, and educator effectiveness (U.S. Department of Education, 2015; Doorey, 2013). Therefore, the tests' appropriateness and usefulness as well as the teachers' abilities to prepare students to display their mathematical understanding on these assessments were relevant and critical topics. The newness of the Smarter Balanced Assessments and the recent implementation of the Washington K-12 Learning Standards have contributed to the limited amount of current supports available.

Definition of Terms

For the purpose of this applied project, the following terms were operationally defined as follows:

Claims – summary statements about the knowledge and skills students will be expected to demonstrate on the Smarter Balanced assessment related to a particular aspect of the standards for mathematics (Smarter Balanced Assessment Consortium, July 2015).

Claim Distribution – visual representations of how content is distributed across the Smarter Balanced assessments (Office of Superintendent, February 19, 2016).

Claims Videos – provide information on the claim structure of the Smarter Balanced assessments and specific information about each claim (Office of Superintendent, February 19, 2016).

Cluster Quizzes – paper-pencil quizzes aligned to selected clusters or conceptual categories from the CCSS-M; may be modified and used to supplement the interim assessment blocks (IABs) (Office of Superintendent, February 19, 2016).

Common Core State Standards – set of high-quality academic standards in mathematics and English Language arts/literacy (ELA) that outline what a student should know and be able to do at the end of each grade (Common Core State Standards, 2016).

Digital Library – a component of the Smarter Balanced assessment system that includes a series of assessment literacy, professional learning, and instructional modules and materials in mathematics contributed by teachers (Smarter Balanced Assessment Consortium, n.d.).

Educational Service District (ESD) – a regional agency that provides educational services and programs to local school districts as well as builds partnerships between K-12 education, early learning, higher education, public and private organizations.

Formative Assessment – a deliberate process used by teachers and students during instruction that provides actionable feedback to adjust ongoing teaching and learning strategies to improve student attainment of curricular learning goals (Smarter Balanced Assessment Consortium, n.d.).

Field – mathematics teachers in the state of Washington.

GovDelivery – the email alert system used to communicate with educators about updates, news releases and other topics from OSPI.

Highly Qualified Teachers – teachers who have bachelor's degrees, full state certification or licensure, and proof that they know the subject they teach (U.S. Department of Education, 2004).

Interim Assessment Blocks (IAB) and Interim Comprehensive Assessments (ICA) – on-line assessments that allow teachers to check student progress throughout the year, giving them actionable information to inform instruction and help students meet the challenge of college- and career-ready standards (Smarter Balanced Assessment Consortium, n.d.).

Item Specification Documents – provide guidance on how to translate the Smarter Balanced Content Specifications into assessment items (Smarter Balanced Assessment Consortium, September 2015).

Mathematics K-12 Learning Standards (the standards) – describe the mathematics that students should know and be able to do at each grade level (Office of Superintendent, March 2016).

OSPI Math Fellows – mathematics teacher leaders that support implementation efforts of the Mathematics K-12 Learning Standards by collaborating at the state, regional, district, and local levels to build coherence by focusing on the shifts in instructional practice to increase student learning (Office of Superintendent, March 2016).

Professional Learning Community (PLC) – a staff development practice where teachers and/or administrators in a school seek and share learning and then act on what they learn to enhance their effectiveness as professionals to benefit students (American Institute for Research, 2015).

Progressions Documents – narrative documents describing the progression of a topic across a number of grade levels, informed both by research on children's cognitive development and by the logical structure of mathematics (University of Arizona, 2013).

Regional Mathematics Coordinators (RMCs) – mathematics leaders in each of the ESDs that support teacher professional development in mathematics.

State Network of Educators (SNE) – educators and administrators from K-12 and higher educational institutions in Washington who work on instructional resources and professional learning support for the Smarter Balanced Digital Library aligned to the Mathematics K-12 Learning Standards (Office of Superintendent, March 2016).

CHAPTER 2

RELATED LITERATURE

Theoretical Framework

The theoretical framework that supports the focus on teachers and their needs in understanding the utilization of supports for classroom instruction in the standards and preparation of students for measurement of the standards on the Smarter Balanced summative assessments comes from Malcolm Knowles' Theory of Adult Learning and his principles of andragogy (Knowles, Holton & Swanson, 2015). Knowles has five assumptions of adult learning (Pappas, 2013) that help frame the development and utilization of the resources to support teacher instruction. The first assumption is self-concept which displays in a teacher as being one who has moved from dependent in nature to self-directed. This project focused on providing supports that could be used by teachers in a timeframe that worked for them as well as at a level that was applicable. This provision helped teachers to self-direct their development. Knowles' second assumption is the adult learning experience highlights that as a person grows he/she acquires a reservoir of experience that becomes a resource for learning. The background and experience that teachers bring when incorporating the Smarter Balanced resources impact and support their abilities to effectively utilize the supports. The third assumption is that adults become increasingly oriented to the developmental tasks necessary to fulfill their social roles. Teachers' readiness to learn is supported by their roles as an educators and need to properly instruct students in the standards. The fourth assumption is orientation to learning which involves moving from subject-centered learning to problem-centered and applying knowledge rather than simply acquiring knowledge. The application of the resources to the teachers' classrooms addressed the problem of not having the proper preparation or background to prepare students in the standards and for the assessments. The final assumption is a shift for adults from an external motivation to learn to an internal one. The resources and supports that were developed were based upon the feedback from the teachers. Therefore, the motivation results from the relevance of the products to the teachers' immediate career situation and need for further support.

The five assumptions of adult learning lead into the Knowles' four principles of andragogy which are applied to the adult learner. The first principle is adults need to be active participants in the planning and evaluation of their instruction. Teachers of the state provided feedback to OSPI that directed the work to support them. The second principle is experience (including mistakes) provided the basis for the learning activities. The lack of preparation or struggle to teach the standards in the past guided teachers in their work and motivated them to focus on gaining additional support. The third principle involves learning subjects that have immediate relevance to their jobs or life are most interesting to adults. The resources that were developed are relevant to a mathematics teacher's current work. And lastly, adult learning is focused on solving problems rather than acquiring content. Teachers are likely not utilizing these resources for the sake of acquiring additional content but for sake of being better prepared to support student learning in preparation for measurement on the assessment.

Literature Review

Because this study focused on supporting teachers in preparing students in the content standards that are measured by the Smarter Balanced Assessments, the relevant literature highlights several key elements including: the assessment system, assessment design, results of high stakes testing, assessment influence on instruction, teaching the standards and using resources to improve instruction, professional development, content expertise, and student awareness. Each of the key elements is described in the following sections. How each element appeared in the development of the resources is also illustrated.

Assessment System

In *Measuring What Really Matters* (2015), Wei, Pecheone and Wilczak described the necessary pieces to create a coherent state assessment system. The system should include not only tests but also instructional resources and professional development (PD). The need for supplements for the current Smarter Balanced assessments in Washington was made evident in the information provided by teachers to OSPI staff and was the main driving force behind this project. Systems of assessment should incorporate multiple measures (Wei et al., 2015). Relying upon a system that utilizes mainly a summative test to inform student growth misses the opportunity of accessing assessment's greater purpose of improving student learning and teacher instruction (Guisbond & National Center, 2012).

For states to establish a coherent system, investment must be made in the local capacity of teachers to be integral players in the development and implementation of the system (Wei et al., 2015). Therefore, the incorporation of teacher input when designing the supports and resources was a valuable factor in this project. Additionally, there should be movement away from a one-size-fits-all approach to professional development (Wei et al., 2015). The resources developed allowed for teachers, schools and districts to customize professional learning times and opportunities in using the materials to support professional growth.

In reciprocal accountability, all levels of the system from the state, districts, schools and teachers must take responsibility and be engaged in building the capacity of the educational system to respond to student learning needs (Wei et al., 2015). Although OSPI developed the resources, it was not without input from local educators. The responsibility of providing information about educator needs fell upon teachers and district personnel to share with OSPI and the development of the resources fell upon state staff. Assessment systems alone cannot guarantee that all students learn. Educators need instructional tools to teach effectively (Armistead & Education Partnerships, 2010). The resources developed supported the instructional needs of educators to better teach the standards and understand the assessment system in order to prepare students for college and career readiness.

Assessment Design

Previous to the development of the Smarter Balanced Assessments, there had been concern about the adequacy of assessments being used in the United States (Armistead & Educational Partnerships, 2010). The United States was one of the only economically advanced nations that relied heavily on multiple-choice tests; other nations used primarily performance-based assessments (Schaeffer, 2012). However, there has been a dramatic advance due to the state-led efforts of creating both the Common Core State Standards in literacy and mathematics along with the U.S. Department of Education’s consortia-led development of new assessments by Partnership for Assessment of Readiness for College and Careers (PARCC) and Smarter Balanced (Armistead & Educational Partnerships, 2010). Washington’s legacy mathematics tests already included performance tasks, assessing more critical thinking and problem solving than most states. But, Washington’s involvement with the Smarter Balanced Assessment Consortium provided an individualized computer adaptive test for every student with questions getting harder when a student answers correctly and easier when they answer incorrectly (Smarter Balanced Assessment Consortium, n.d.).

The focus of summative assessments is to elicit evidence of what the examinee knows and can do (Huff, Steinberg & Matts, 2010). To accomplish this, the types of observations that provide the evidence needed must be determined and frameworks designed to interpret these observations (Huff et al., 2010). In today's field of assessment development, detailed frameworks for item specifications, task models, quality criteria, and review processes are in place in order to ensure valid, reliable and unbiased results (Wei et al., 2015). These assessments should allow for students in all ranges of the achievement continuum to show what they know and can do with the expectations being clear and transparent (Armistead & Educational Partnerships, 2010). Assessment should be student-centered and focused on highlighting individualized growth, and informative and useful for a variety of audiences (Andrade, Huff & Brooke, 2012). The new Smarter Balanced assessments used in Washington are designed to give teachers and parents better information to help students succeed as well as a realistic baseline that provides a more accurate indicator of the student's ability to meet the rigorous demands of college and career (Smarter Balanced Assessment Consortium, n.d.).

One aspect of the supports developed in this project focused on leveraging the resources available from Smarter Balanced. The Item Specification documents (Smarter Balanced Assessment Consortium, September 2015) – highlighted as an important tool in assessment design – were utilized when developing the Cluster Quizzes (Appendix C). Guidance for the digital library provided direction for incorporating formative assessment resources into classroom instruction and creating a more student-centered focus. The Interim Assessments – both the Interim Assessment Blocks (IABs) and Interim Comprehensive Assessments (ICAs) – that are part of the Smarter Balanced assessment system in Washington– made access to the expectations of the summative test both clearer and transparent for educators and students.

Results of High Stakes Testing

Increasing numbers of parents, teachers, administrators and students have protested high stakes testing (Schaeffer, 2012). In recent years, global increases in high-stakes testing have driven instruction in undesirable ways (Amador & Lamberg, 2013, Wei et al., 2015). In fact, many schools have responded to these annual assessments by enacting drill and kill instruction in hopes of having students practice and prepare test items and skills (Schaeffer, 2012). Testing critics have claimed that instruction has been dumbed-down and creativity lost in classrooms (Schaeffer, 2012). Unfortunately, this narrowed approach to instruction has had a negative impact on student learning and done little to nothing to improve test scores or achieve Adequate Yearly Progress (AYP) or a 100 percent proficiency rating on the mathematics annual assessment (Office of Superintendent, July 2015).

Schools that did not meet requirements of AYP could have steps taken to improve the school including replacement of staff, restructuring of the school, or having a private company or state office of education run the school. Unfortunately, the consequences of poor performance on the accountability assessments were so stringent that educators sometimes felt the pressure to focus instruction on preparing students for those tests which had the unintended consequence of narrowing the curriculum and de-prioritizing educational opportunities for students (Guisbond & National Center, 2012). There has been ample evidence that high stakes testing coupled with sanctions without addressing other educational issues have caused the No Child Left Behind Act (NCLB) to fail (Guisbond & National Center, 2012). The reauthorized NCLB Act, Every Student Succeeds Act (ESSA), continues the requirement of annual summative tests administered to students in each state for purposes of providing information to parents and students (U.S.

Department of Education, 2015). The resources created in this project attempt to address the educational needs of students as measured by the assessments.

Assessment Influence on Instruction

Preparing students to take standardized tests without “teaching to the test” may sound like an implausible task, however teachers can move away from this narrow approach to teaching to integrating test preparation into their regular instruction (Kalchman, 2011). In *Using the Math in Everyday Life to Improve Student Learning* (Kalchman, 2011), students wrote about authentic, real-life experiences that required them to use mathematics. Students began to see connections between the mathematics that they learned in school to the mathematical demands in their lives. Students claimed that doing these tasks made mathematics easier because it helped them to write about their problem solving and explain their steps. When students had to communicate about their process, they learned to be clear and convincing. True mathematics problem solving and alignment to the standards lent itself to better test prep than “drill and kill”.

Recent reform in mathematics has shown that teaching for conceptual understanding through problem solving and sense making has been stifled by increased emphasis on high stakes assessments (Amador & Lamberg, 2013). In fact, teaching practices have changed to focus on preparing students for high stakes tests. However, these high stakes tests can be powerful leverage points (for the positive or negative) to influence what is taught and how (Amador & Lamberg, 2013). In *Learning Trajectories, Lesson Planning, Affordances, and Constraints in the Design and Enactment of Mathematics Teaching* (Amador & Lamberg, 2013), several veteran teachers fostered a learning environment that focused on teaching test content. Student achievement on high-stakes testing drove what was taught in the classroom. Lesson planning centered around what was going to be on the test. Conceptual understanding was less important than the skills and procedures essential for the test. Teaching material outside of the tested questions and content was considered a waste of time. One teacher directed her students to follow her procedure for problem solving, but failed to emphasize mathematical understanding.

A novice teacher in the same school approached testing differently than the veteran teachers by using it as a gauge of the conceptual understanding of her students to help her design future instruction. This teacher took the time to reteach concepts as necessary until she was confident that her students understood. She routinely adjusted her lesson plans and used formative assessment to gain understanding of student thinking. Student understanding was her driving force for instructional decision making. The result was that effective mathematics teaching did not need to be lost due to testing. Conceptual mathematical understanding could be reached by focusing on effective teaching centered on the standards as opposed to procedural knowledge aligned to the standards.

This approach to “teaching to the test” and narrowing of curriculum was evident in some of the initial feedback provided to OSPI staff. Teachers asked for samples of test items that they could use as teaching materials in their classrooms as opposed to support for teaching the standards. The intent of gathering further data from teachers of the state was to provide information on teacher awareness, understanding and use of current supports to guide design of additional resources, and how to best communicate to the field about resource availability to help alleviate an over emphasis on procedural knowledge. Understanding that teachers do focus instruction on the content of the assessment, the resources that were provided aimed at providing teachers with guidance on developing greater understanding of progressions of content (guidance documents for the Progressions), mathematical practices (Claims Videos), supports for formative assessment (Digital Library resources) and interim assessments to support intermediate gauging of student understanding (Cluster Quizzes). The focus was to direct teachers in developing conceptual understanding in their instruction with use of the supports.

Teaching the Standards and Using Resources to Improve Instruction

Adoption of the Standards presented an opportunity for systemic improvement in mathematics education by developing a more rigorous, focused, and coherent curricula, instruction, and assessments for mathematics promoting conceptual understanding, reasoning and fluency in the skills that would prepare students for college and career (Martin, 2015). The Standards were designed to encourage students to think deeper and to acquire understanding of how algorithms work at earlier grades allowing for development of fundamental skills and background to think critically about math (Regional Educational Laboratory & International ICF, 2015). The goal of standards-based instruction was to ensure equitable instruction across U.S. schools and to set high expectations for the success of all students (Elish-Piper, Matthews & Risko, 2013).

Teachers should focus on the Standards that the assessments are meant to measure rather than allow test preparation or textbooks to guide instruction (Cogan, Burroughs & Schmidt, 2015). When looking at resources that support instruction in the Standards, it was found that average textbooks covered only one-half to two-thirds of the standards appropriate for that grade (Cogan et al., 2015) and coverage did not necessarily mean teaching for conceptual understanding. Student learning is a product of a well-designed learning environment and carefully designed lessons aligned to the standards that include learner-centered activities and appropriate supports for teachers (Myers, Sztajn, Wilson & Edgington, 2015). With the most current educational resources lacking adequate alignment to the standards (Regional Educational Laboratory & International ICF, 2015), the resources developed for this project aligned directly to the standards at a particular grade level or band and focused on supporting teachers in classroom instruction that aimed at building conceptual understanding of mathematics content and procedures.

Professional Development

Teachers' abilities to continually update their skills and add to their knowledge base through Professional Development (PD) are critical components of teaching reforms (McGee, Wang & Drew, 2013). This process requires that instructors seek new knowledge on a regular basis (Youngs & Center for American Progress, 2013). When teachers regularly engage in PD, they are participating in work that can create structural change in how they approach their teaching. In fact, rather than expecting teachers to make pedagogical or curricular changes quickly, a better and more manageable approach is to ask them to make small changes by regularly trying out new information in their classrooms (Frost, Coomes & Lindeblad, 2012). The supports that were designed took into account this critical component of professional development and incorporated guidance on how to make incremental changes. The various resources that were produced can be studied and parts of them can be incorporated over the school year and over several years. The goal was to develop understanding and awareness of what resources were available and could be incorporated to support classroom instruction.

With the incorporation of new standards and the administration of new assessments, more investment in teacher professional learning is needed (Wei et al. 2015). Educators when asked to make substantial changes in their mathematics teaching desired additional instructional resources and supports (Kirk et al., 2014). Providing opportunities for educators to network and have access to PD affords teachers the help needed to have better understanding of what is required to implement the Standards and integrate them into their daily math instruction (Kirk et al., 2014). Research highlights the importance of individualized approaches to ongoing professional learning embedded throughout the teacher workday using tools such as observations, modeling, and reflective dialogue (Ittner, Helman, Burns & McComas, 2015). This type of collaborative professional learning and teamwork helps to improve a teacher's craft and utilizes the collective expertise to benefit the school community and increase student learning (Schiff, Herzog, Farley-Ripple & Iannuccilli, 2015). The Critical Questions for the Progressions Documents resource (Appendix D) that was produced for this project is an example of a support aimed at encouraging teachers to engage in deeper conversation and was intended to be used during department, professional learning community (PLC) or staff meeting times.

In Knowles' four principles of andragogy, the first principle of adult learning is that adults need to be active participants in planning their instruction (Knowles et al., 2015). It is widely recognized that K-12 teacher PD is a critical component to improving the quality of education in the United States (Jones & Dexter, 2014). People other than teachers often design and dictate content and format of PD experiences (Jones & Dexter, 2014). This process ignores teacher voice and wastes an opportunity to capitalize on teacher experience and expertise. This project took that view of PD into account by basing the focus, design, and communication out of the resources on the direct feedback and ideas shared by educators with respect to what they most needed to aid them in instruction and support.

Content Expertise

Teacher content expertise is a critical element in helping students learn and achieve as well as create greater educational equality (Kanes, Morgan & Tsatsaroni, 2014). Teachers must develop and deepen their own mathematical content expertise (Moyer-Packenham & Westenskow, 2012). To improve teacher knowledge and skills in classroom practice, there must be a focus on content knowledge and opportunities for active learning (Jones & Dexter, 2014). Just as students need opportunities to learn, so do teachers (Jones & Dexter, 2014). Participating in mathematical problem solving enables teachers to experience and identify various mathematical approaches that serve to support understanding the diversity of student learning needs (Bailey & Taylor, 2015).

Related directly to the Progressions Documents (Appendix D) are Learning Trajectories (LT) in teaching. With the release of the Standards, attention to the role of LT has increased (Wilson, Sztajn, Edgington & Confrey, 2014). After learning about LT, teachers' knowledge on mathematical content improved and began to increase; teachers began to make connections between the topics of mathematics (Wilson et al., 2014). This development of teacher awareness of how topics are related over the span of mathematics is powerful in properly delivering instruction aligned to the Standards and preparing students for the Smarter Balanced Assessments.

Student Awareness

Teachers as the primary agents of content delivery need to aid students in becoming thoughtful decision makers who are able to think, use and apply information (Gordon, 2011). Studies have found that American students have strong abilities in computation but that reasoning through complex mathematical problems proves challenging (Scher & O'Reilly, 2009). Since many textbooks have not provided much in the organization or coherence of facts, the real understanding of the subject comes from the teacher who plays a significant role in the improvement of student achievement (Scher & O'Reilly, 2009). Teachers with deep conceptual understanding of mathematics will be able to make sense of nonstandard student solutions as well as recognize student misconceptions and respond instructionally to them (Regional Educational Laboratory & International ICF, 2015; Wilson et al., 2014). Encouraging students to explain the logic behind their thinking is a powerful guide to help students make sense of problem situations and connect mathematical relationships (Council of the Great City Schools, 2014).

In addition to addressing students' mathematical understanding, teachers' attitudes and beliefs can be reflected in their students. Students need to know that teachers care (Elish-Piper et al., 2013). Educators should not get overly focused on standards, curriculum, and assessments to the detriment of letting their students know that they are important and matter individually (Elish-Piper et al., 2013). When students are in classrooms where they feel safe, connected and supported, they are more likely to perform higher and have positive attitudes toward school and learning (Elish-Piper et al., 2013). Educators need to project a confident attitude towards the process of learning and assessment or it has been found that students will manifest the anxiety of adults at the school during learning and testing (Elish-Piper et al., 2013). By providing supports and guidance for teachers to better utilize the Smarter Balanced resources, as well as developing additional resources, teachers have the opportunity to develop deeper knowledge about mathematical content and practices as well as better familiarity with test make-up to create a more relaxed and informed environment around both teaching and assessing standards.

CHAPTER 3

APPLIED PROJECT DESIGN

Guiding Questions

The following were guiding questions for this project:

1. What additional resources do teachers need to support classroom instruction for preparation of students prior to the Smarter Balanced summative assessments in mathematics?
2. What guidance do teachers need to more effectively utilize the current, and future, resources for the Smarter Balanced summative assessments in mathematics in their classroom instruction?
3. What are more effective ways to organize, post, and communicate about the resources for the Smarter Balanced summative assessments in mathematics?

Project Parameters

The scope of this project was to analyze the data gathered from teachers at the end of the 2014-2015 school year on their familiarity and use of the Smarter Balanced assessment resources for mathematics. From this analysis, resources were designed to address the needs as expressed by the teachers. These resources were posted to the OSPI website with communication going out to the field via e-mail listserv, during statewide conference presentations including the Washington Educational Research Association (WERA) conference, and by the teaching & learning department at OSPI during professional development. The projected plan resided within the scope of work and responsibility that OSPI staff have in their job descriptions and supported part of the mission of the agency to provide resources that enable educators to ensure students succeed in public schools, are prepared to access post-secondary training and education, and are equipped to thrive in their careers and lives (Office of Superintendent, September 2015).

Project Methodology

A survey (Appendix A) was sent out to mathematics teachers in the state of Washington at the end of the 2015 school year for the purpose of gathering information on both the extent to which teachers had used the available Smarter Balanced assessment resources and how they were used. The survey was sent out via SurveyGizmo® and did not ask for any identifying information such as the teacher's name or school. In order to know to which level (elementary, middle or high school) the feedback applied, teachers did supply information on what grade band they taught (3-5, 6-8 or high school). District information was also gathered to determine if the data were representative of the state. This applied project analyzed the data that were collected in the original information-gathering survey with the purpose of determining what additional resources and guidance should be produced and provided to aid teachers in preparing students for the Smarter Balanced assessments in mathematics.

Demographics

The demographic information for teachers in the state of Washington was recorded in the State Report Card (Office of Superintendent, February 5, 2016). In the 2014-2015 school year, there were 60,543 teachers in the state of Washington. The average years of teacher experience was 13.6. The percentage of teachers with at least a Master's Degree was 67.2%. The percent of classes taught by teachers meeting the definition of highly qualified (U.S. Department of Education, 2004) was 96.8%. The percent of teachers not meeting the definition of highly qualified was 3.2%. There were 295 school districts. Of the nine educational service districts (ESDs), four were on the east side of the state (101, 105, 123 and 171) and five (112, 113, 114, 121, and 189) were on the west side. The survey was sent out to the OSPI's mathematics email listserv which contained approximately 3,000 subscribers and was a subgroup of all mathematics teachers in the state, most likely containing some non-teachers and out-of-math content teachers. Of the 517 total surveys started, 376 were completed and 141 were partially complete.

Historical Issues of Importance

The No Child Left Behind Act of 2001 (NCLB) was an Act of the U.S. Congress which reauthorized the Elementary and Secondary Education Act (ESEA) to support disadvantaged students and to close the achievement gap with accountability, flexibility, and choice (U.S. Department of Education, 2002). The NCLB required that all public schools administer a statewide standardized test annually to students and meet the requirements of Adequate Yearly Progress (AYP) in test scores. In order to measure student progress, the U.S. Department of Education awarded two assessment consortia $330 million in competitive grants to develop assessments aligned to the Common Core State Standards (National Conference, 2016). $186 million was presented to the Partnership for Assessment of Readiness for College and Career (PARCC) and $176 million to the Smarter Balanced Assessment Consortium (Smarter Balanced). States could participate in the consortia as either governing states or participating/advisory states. Washington joined Smarter Balanced as a governing state. As a governing state Washington signed an agreement to administer the consortium's assessments for purposes of federal accountability testing (National Conference, 2016).

Sequence of Activities

Based upon initial information provided by teachers during committee meetings and trainings, OSPI staff determined that gathering more specific data on Smarter Balanced resource use would be useful information.

- In June of 2015, a survey was sent out to mathematics teachers in the state of Washington to determine the extent to which Smarter Balanced resources had been used to prepare students for the assessments as well as how those resources were used.
- During the summer of 2015, OSPI staff examined the data and determined that additional supports and resources were needed to support teachers in teaching the standards in preparation of students for the Smarter Balanced assessments in mathematics.

The data from this survey were intended to provide information on the extent to which resources were being used by teachers in the state. For this capstone, the existing data from the initial survey were analyzed to determine what resources needed to be developed to support teachers' classroom instruction in the standards for preparation of their students to take the Smarter Balanced assessments in mathematics.

- In late October and early November of 2015, the data were analyzed to determine what resources would be produced to support classroom instruction for the Smarter Balanced assessments in mathematics.
- In late November and early December of 2015, analysis of the data were presented to OSPI staff and resources and guidance were produced to address teacher needs as determined by the survey.
- In January of 2016, OSPI posted the produced resources to their website and highlighted them during the WERA conference presentations. To further inform the field of the new

resources, communications were sent out via the mathematics e-mail listserv on OSPI's GovDelivery system.

Outcomes

Initiated by conversations with teachers, OSPI mathematics assessment staff determined that the teacher feedback survey would be a useful outlet for mathematics educators to express their concerns and needs. Upon conducting a secondary analysis of the survey data, teacher resources were developed to support classroom instruction of the standards as measured by the Smarter Balanced assessments. These resources included Range Achievement Level Descriptors (ALDs) (Appendix B), Cluster Quizzes (Appendix C), Critical Questions for the Progressions Documents (Appendix D) and Digital Library Resources Guide (Appendix E). In conjunction with the Teaching and Learning department at OSPI, resources on the website, both old and new, were re-organized and sorted by grade level to help educators better understand what resources they needed to access based upon their grade level taught. Communication about the new resources went out via GovDelivery for educators who subscribed to the mathematics email listserv (Appendix F). The resources have also been used during statewide presentations at the Washington Educational Research Association (WERA) (Appendix G). Guidance on how to utilize the resources to support classroom instruction has been included within the documents and on the website.

Evaluation Methods

Survey Description

General applicant information and background information was gathered in the first two sections of the survey. Following these sections were nine additional sections: Mathematics

Standards Experience, Progressions Documents, Digital Library, Claim Distribution Documents, Item Specification Documents, Claims Videos, Interim Assessment Blocks (IAB), Interim Comprehensive Assessment (ICA) and Additional Questions. The first eight sections included question(s) that required a Likert rating and the last eight sections included question(s) that indicated a written response.

Data Analysis

The survey questions that provided narrative responses were analyzed using Open Text Analysis in SurveyGizmo® and categorized according to common words and themes. Individual responses contributed to multiple categories if the information contained provided useful insight for more than one area. Data from questions that requested a Likert rating were not numerically analyzed in the first examination. Data from these questions were evaluated using downloadable data displays from SurveyGizmo® to gain general insight into teacher familiarity and use of the resources. The analysis was quantitative to determine the extent to which teachers have utilized resources previously and qualitative to inform next steps.

CHAPTER 4

FINDINGS AND IMPLICATIONS

After the Mathematics K-12 Learning Standards were adopted in Washington, OSPI provided a three-year transition plan to assist classroom teachers in implementing the standards, see Appendix H (Office of Superintendent, October 2015). Spring 2015 was the first administration of the Smarter Balanced summative assessments measuring student progress toward learning these standards. On the survey, the questions were asked of teachers about their study of the standards, the alignment of their classroom with the standards and if they could deliver training on the standards. The results are displayed in Table 1.

Table 1

Teacher Rating of Experience with the Mathematics K-12 Learning Standards

	Not at all	2	3	4	Completely	Responses
I have studied the standards for the grade level(s) I teach.	3 0.8%	11 2.9%	47 12.5%	147 39.1%	168 44.7%	376
My classroom instruction is aligned with the standards.	7 1.9%	15 4.0%	75 19.9%	141 37.5%	138 36.7%	376
I could deliver training on the standards.	56 14.9%	71 18.9%	112 29.8%	70 18.6%	67 17.8%	376

After over three years of transition, less than half of the respondents (44.7%) had "completely" studied the standards for the grade(s) in which they taught and just over a third (36.7%) had completely aligned their instruction. Although, when combining "complete" (rating of 5) to "nearly complete" (rating of 4) the percentages increased to 83.8% for study of the standards and 74.2% for instruction aligned. What this indicates is, even with a plan for full implementation by the 2013-2014 school year in preparation for administration of the summative tests, teachers had not fully aligned instruction to the standards that would be assessed on the assessments.

Resources

Several resources were available for teachers to assist them in understanding how the summative assessment items were structured to measure student progress toward learning the standards. The information contained in these resources could help teachers understand how student understanding is measured and assist in designing instruction around the standards. The responses in the survey provided insight into how familiar teachers were with these resources as well as how often and how they were used.

Progressions Documents

The progressions documents were used by the Teaching and Learning Department at OSPI and RMCs to support teacher understanding of how the content standards progress across grades to inform organization of curriculum and classroom instruction. Figure 1 displays teacher familiarity and use of this resource.

Value	Percent	Count
1-Not aware of them	31.1%	117
2-Aware but not currently using	20.0%	75
3-Reviewed and intend to use	18.4%	69
4-Used the resource periodically to support instruction	22.1%	83
5-Used the resource consistently to support instruction	8.5%	32
	Total	376

Figure 1. Respondents' Experience with the Progressions Documents

The data showed that nearly one-third of the respondents (31.1%) were not aware of this resource, around 70% were not using it and less than one-tenth (8.5%) used it consistently. In addition, when asked about what barriers impacted use of this resource, the top reason (63.5%) was not enough time, followed closely with 51.8% of the respondents marking "school/district efforts have focused in other areas". Figure 2 displays the responses.

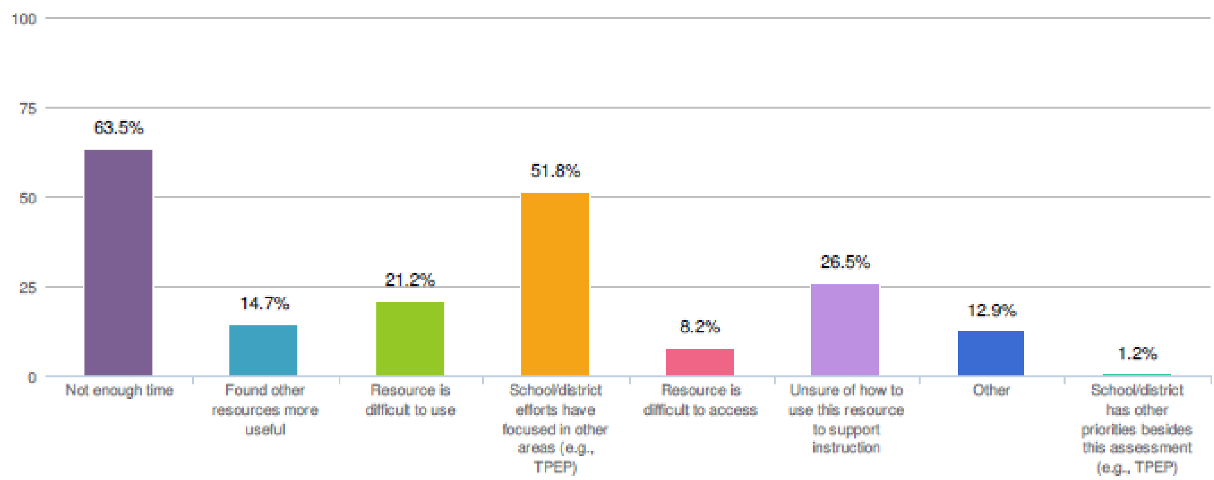


Figure 2. Respondents Experience with the Digital Library

General themes that surfaced in the open responses for the progressions documents:

- Teachers were not aware of or had the documents shared with them.
- The resource was too dense. It needed to be broken into smaller "chunks".
- Teachers needed collaborative time to review the resource.

As a result of this input and to support teachers use of this document, OSPI provided access to the documents by grade level and formulated focus questions to accompany each document that could be used in grade or content level team meetings or professional learning community (PLC) time to assist in professional development. See Appendix D for an example of Critical Questions for the Progressions Document.

Digital Library

The Smarter Balanced assessment system has three main components, see Appendix I (Smarter Balanced Assessment Consortium, n.d.). The first is the summative test that is the end-of-year assessment designed for accountability purposes and provides feedback on students' growth toward (grades 3-8) or readiness for (grade 11) college and career. The second component is the interim assessments, detailed later in this section, which are designed to support teaching and learning throughout the year by providing actionable feedback. The third component is the Digital Library which contains instructional and professional learning resources through formative assessment materials. The Digital Library provides social networking amongst educators by allowing them to rate and share which resources they have found helpful.

The Digital Library became available for use by teachers in September of 2014. The library contained over 2700 resources and was interactive allowing the user to search materials by criteria such as grade level, Common Core standard, target student population or formative assessment attribute. When respondents described their experience with the Digital Library, less than 1% (0.8%) used the resource consistently with an additional 14.7% using the resource periodically. This left nearly 85% of the respondents not using the resource at all even though 22.7% indicated an intent to use. Figure 3 displays the responses.

Value	Percent	Count
1-Not aware of it	19.5%	73
2-Aware but not currently using	42.4%	159
3-Reviewed and intend to use	22.7%	85
4-Used the resource periodically to support instruction	14.7%	55
5-Used the resource consistently to support instruction	0.8%	3
	Total	375

Figure 3. Respondents Experience with the Digital Library

When queried about the barriers to using the resource, the most frequently cited reason was "Not enough time" (55.4%). With over one-third of the responses indicating both "Found other resources more useful" and "Resource is difficult to use", there appeared to be need for support in finding both the usefulness of the resource and in how to use it. Figure 4 displays the responses.

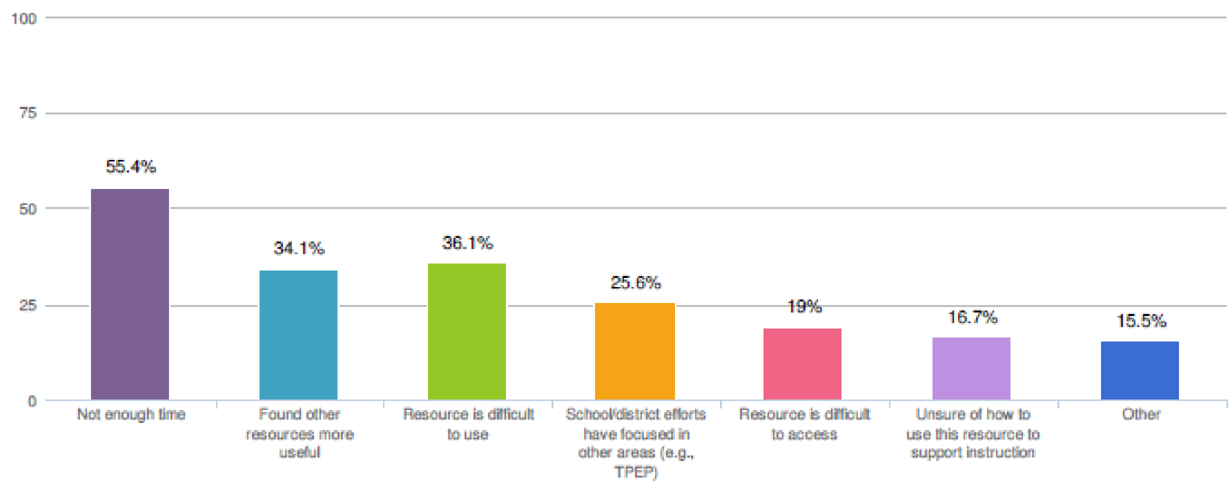


Figure 4. Barriers to Using the Digital Library

General themes that surfaced in the open responses for the Digital Library:

- The filters were not helpful and either rendered no resources or too many.
- Many of the resources were not top quality, there are better resources available.
- Need better instruction of how to use the resource.

In response to the input from the survey, OSPI provided Digital Library Resource Guides (Appendix E). The guides were posted by grade level on the OSPI website and identified modules and resources that would assist teachers in understanding and using formative assessment practices. In addition, content specific exemplar modules were highlighted to help educators see the quality and usefulness of available resources.

Claim Distribution Documents

The documents were created by OSPI to visually display the claim(s) that the standards were eligible to be assessed in on the Smarter Balanced summative assessment at a particular grade. The overwhelming numerical response was no awareness of the existence of this resource with nearly 50% of the respondents marking “Not aware of them”. Just over 20% used the resource to periodically or consistently support instruction. Figure 5 displays the responses.

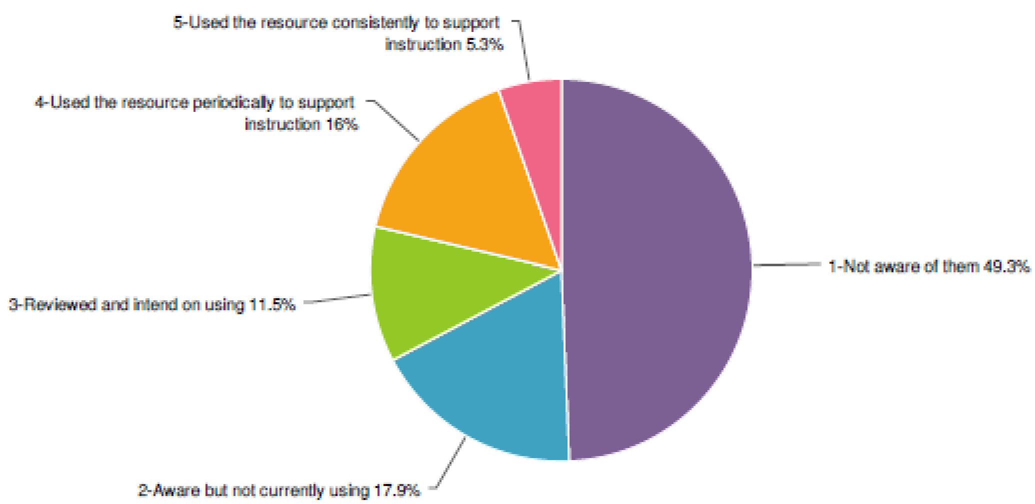


Figure 5. Respondent Experience with the Claim Distribution Documents

For those respondents who were aware of the resource, but were not using it, the top reason with 56.3% marking was “Not enough time”. Followed with 30.4% citing “School/district efforts have focused in other areas”. Additionally, 28.2% of respondents were unsure how to use the resource to support instruction. Figure 6 displays the responses.

Value	Percent	Count
Not enough time	56.3%	76
Found other resources more useful	14.1%	19
Resource is difficult to use	16.3%	22
School/district efforts have focused in other areas (e.g., TPEP)	30.4%	41
Resource is difficult to access	12.6%	17
Unsure of how to use this resource to support instruction	28.2%	38
Other	17.0%	23
	Total	135

Figure 6. Barriers to Using the Claim Distribution Documents

General themes that surfaced in the open responses for the claim distribution documents:

- Need more training in understanding how to use this document.
- Make sure the information about documents such as these is communicated to the field and in a timely manner.
- Those using the documents found them helpful in understanding the standards and types of tasks (items) that align.

In response to the teacher input from the survey and in support of teacher use of this document, OSPI provided access to the documents by grade level and communicated out to the field about the availability of this and other resources (See Appendix F).

Item Specification Documents

The documents provide guidance on how to translate standard and claim specifications into actual assessment items. Included in the documents were examples of items and item types as well as task models that indicate different ways content may be assessed. Teachers have asked for sample assessment items which are available in these documents. In comparison to the teachers' awareness of the claims distribution document, respondents appeared much more aware of the existence of the item specification documents. This awareness could be in part to the training in which these documents were used that OSPI Mathematics Assessment staff provided in January and February of 2014 at six locations throughout the state to approximately 180 educators. More than 75% of the responses indicated awareness, having reviewed and/or used them. Figure 7 displays the responses.

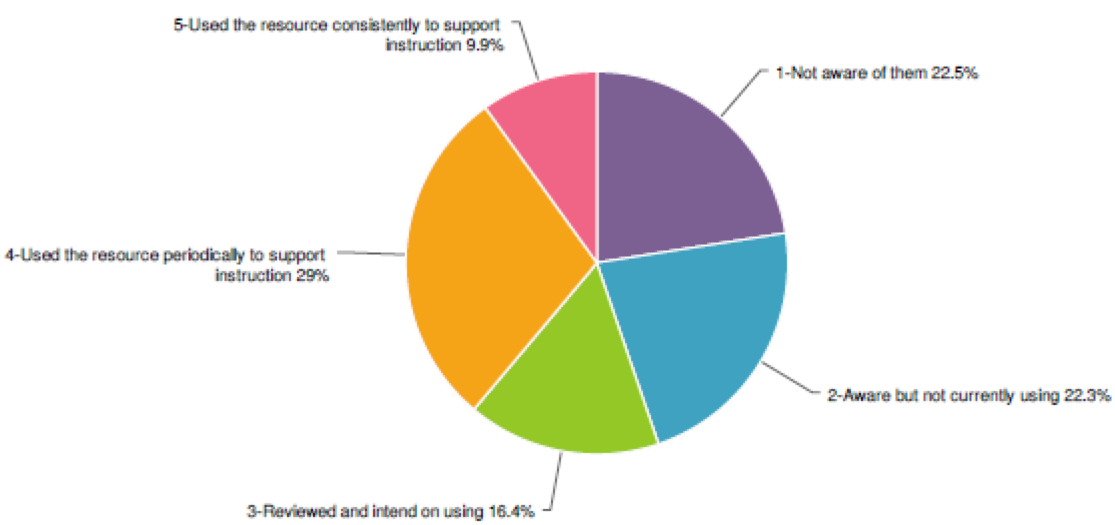


Figure 7. Respondents Experience with the Item Specification Documents

As was true with the progressions documents, Digital Library and claim distribution documents, "Not enough time" was the top barrier to using this resource at 65.4%. Just over one-third of the respondents noted their school/district had other focuses as a barrier. Figure 8 displays the responses.

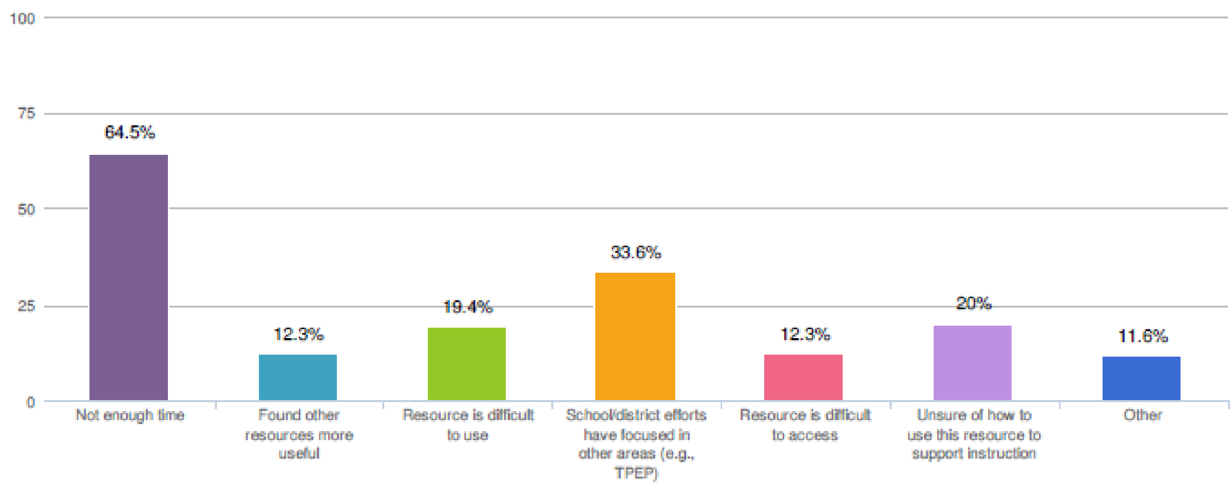


Figure 8. Barriers to Using the Item Specification Documents

General themes that surfaced in the open responses for the item specification documents:

- Document is too lengthy to read through. Needs to be more concise.
- Document has been shown to teachers, but no instruction in its use. Need training.
- Create a bank of sample items in an editable format. Provide this information in a useful format (where teachers do not have to cut/paste).

The respondent input provided ideas to help support use of this resource. OSPI created “Quizzes” using the items from the item specification documents and placed them into an editable format that teachers could add to or re-arrange for use in their classrooms (Appendix C). This addressed the need for a more concise format and provided a bank of sample items where teachers did not need to do the work of cutting and pasting a document together.

Claims Videos

The four mathematical claims of the Smarter Balanced Assessment system, see Appendix J (Smarter Balanced Assessment Consortium, n.d.), are based upon the eight mathematical practices found in the Common Core State Standards, see Appendix K (Common Core State Standards Initiative, 2016). To assist teachers in understanding these claims and how they can be applied to classroom instruction, the OSPI mathematics assessment department put together claims videos. The videos were posted to the OSPI website in January of 2015 with communication going out to the field via the mathematics email listserv. However, with this mid-year timing of uploading this resource, most respondents (78.6%) were not aware of the existence. Less than 5% of the respondents were using this resource either periodically or consistently. Figure 9 displays the responses.

Value	Percent	Count
1-Not aware of them	78.6%	293
2-Aware but not currently using	12.9%	48
3-Reviewed and intend on using	4.0%	15
4-Used the resource periodically to support instruction	3.8%	14
5-Used the resource consistently to support instruction	0.8%	3
	Total	373

Figure 9. Respondents Experience with the Claims Videos

As was true for the previous resources, the top reason for not using this resource was not enough time with 64.2%. School and district efforts in other areas also ranked as another barrier at 22.1%. Figure 10 displays the responses.

Value	Percent	Count
Not enough time	64.2%	61
Found other resources more useful	16.8%	16
Resource is difficult to use	7.4%	7
School/district efforts have focused in other areas (e.g., TPEP)	22.1%	21
Resource is difficult to access	8.4%	8
Unsure of how to use this resource to support instruction	15.8%	15
Other	16.8%	16
	Total	95

Figure 10. Barriers to Using the Claims Videos

Common themes that surfaced in the open responses about the claims videos:

- Release the resources much earlier before the assessment to encourage better utilization.
- Provide trainings through ESDs or districts on using the resource.
- Better communication about the existence of the resource.

To address the needs that respondents expressed, OSPI moved the claims videos to the top of the resource list, so as educators view the list of resources on the website the videos are highlighted.

Interim Assessments

The Smarter Balanced interim assessments include two distinct tests (Appendix I). The Interim Comprehensive Assessment (ICA) uses the same blueprint as the summative assessment and assesses the same standards. The Interim Assessment Blocks (IABs) focus on a smaller set of standards and can be more flexible in supporting instruction. About half of the respondents

(43.4% for IABs and 55.1% for the ICA) were unaware or did not intend to use the interim assessments. About one-fifth of the respondents (20.1%) used the ICA and just over 30% used the IABs. Figures 11 and 12 display the responses.

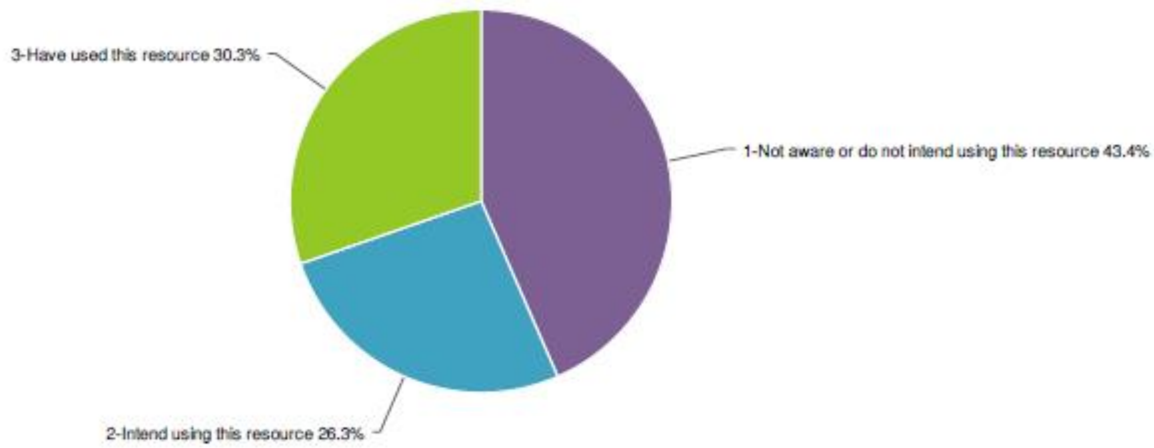


Figure 11. Respondent Experience with the Interim Assessment Blocks (IABs)

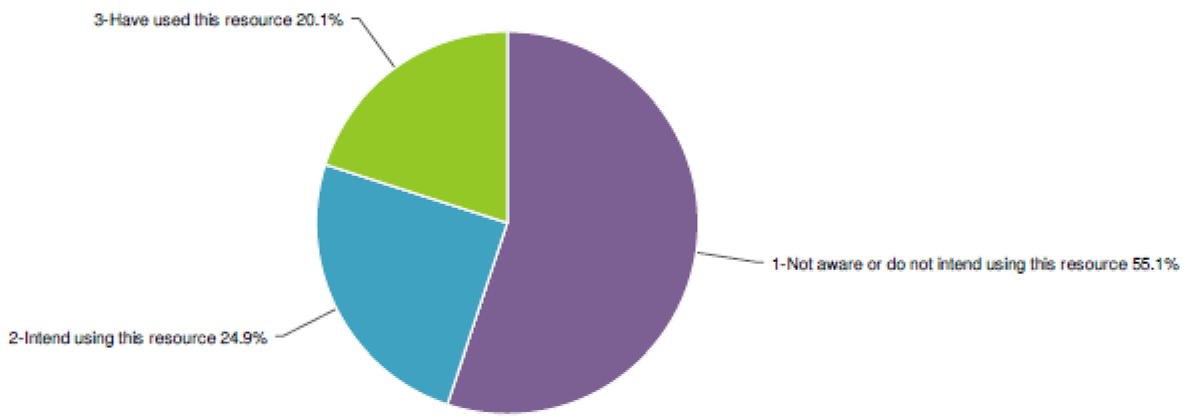


Figure 12. Respondent Experience with the Interim Comprehensive Assessment (ICA)

The common theme for reasons that teachers were not using the resources continued for the interim assessments. “Not enough time” ranked as the top reason at 47% for the IABs and 55.2% for the ICA. “School/District efforts have focused in other areas” was marked by about a quarter of the respondents for each type of interim assessment. Figures 13 and 14 display the responses.

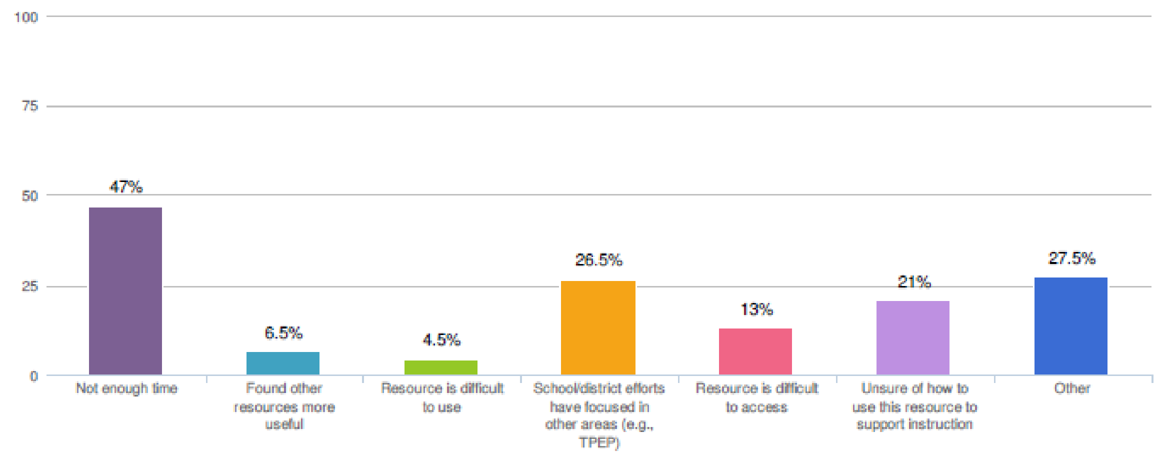


Figure 13. Barriers to Using the Interim Assessment Blocks (IABs)

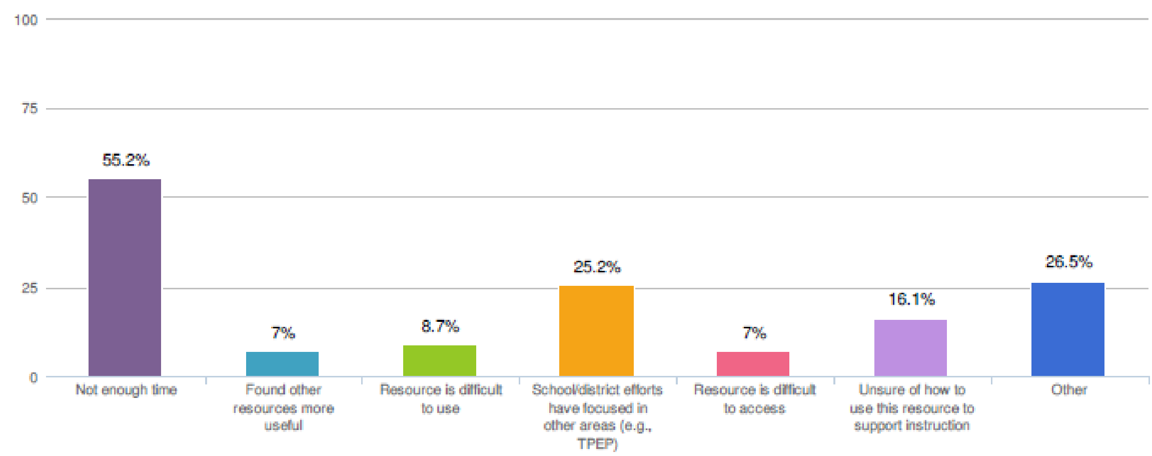


Figure 14. Barriers to Using the Interim Comprehensive Assessment (ICA)

General themes that surfaced in the open responses for the interim assessments:

- Provide more detailed feedback of student performance on the interim assessments.
- Provide more interim assessments for each mathematical strand.
- Let teachers see samples of the items.

To address the needs expressed by the teachers, OSPI provided information back to American Institutes for Research (AIR), the vendor for Washington responsible for delivering the assessments and providing the reports of student performance. As a result, AIR provided more detailed feedback for teachers in the performance reports. Teachers can now access individual student data on performance per item on the interim assessment as well as classroom level data. Both of these allow teachers more useful information to inform instruction and student support. In addition, teachers and district level personnel now have access to the actual items on the interim assessments through the Assessment Viewing Application (AVA). To address the need of provision of additional assessment blocks to address more mathematical "strands" (content), OSPI (using publically available resources such as the Item Specification documents) designed "Quizzes" (Appendix C) to supplement in the content area for which there were no IABs yet built.

CHAPTER 5

SUMMARY AND DISCUSSION

Generalizability

Of the 65,543 teachers in Washington, 517 or less than 1% responded to the survey and 376 completed it. However, the representative nature of this respondent group to the larger population of teachers was good. The demographic information that follows is based on the respondent information from the completed surveys.

The data collected in the survey included representation from a variety of locales in the state. The representation did not have to be equal as the population in different areas varies. Figure 15 shows the percentage distribution of the responses based upon ESD region. About one-third (33.6%) of the responses came from the east side and just under two-thirds (64.6%) came from the west side. ESD 112 had the greatest participation rate providing nearly one-quarter of the responses at 23.4%. Additionally, of the 295 school districts in the state, 115 were represented in the responses.

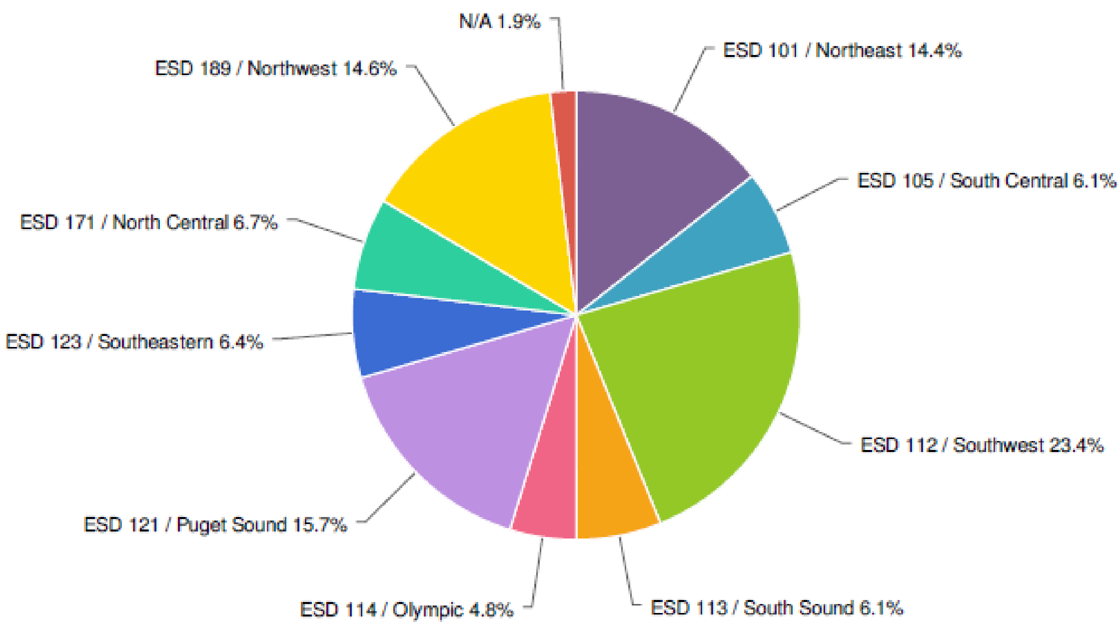


Figure 15. Survey Responses by ESD Region in Washington

The response rate by region provided good coverage of the state.

To determine what types of respondents provided feedback, the question of "Current Position" was asked on the survey. The majority of the respondents were classroom teachers

(83.5%) followed by mathematics coaches at 12.5%. Respondents could mark more than one applicable category. Figure 16 provides an overview of the response rate by position.

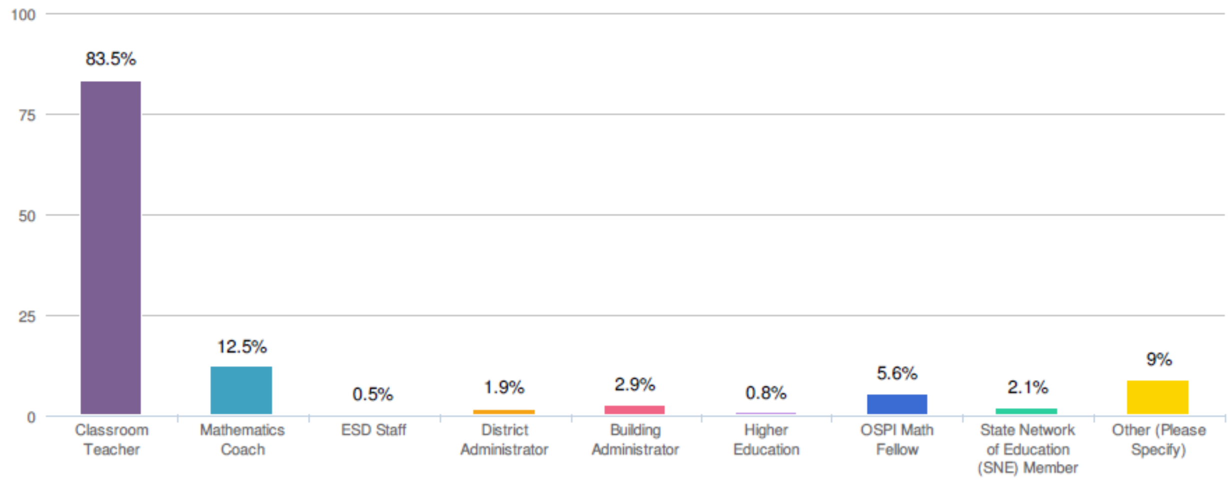
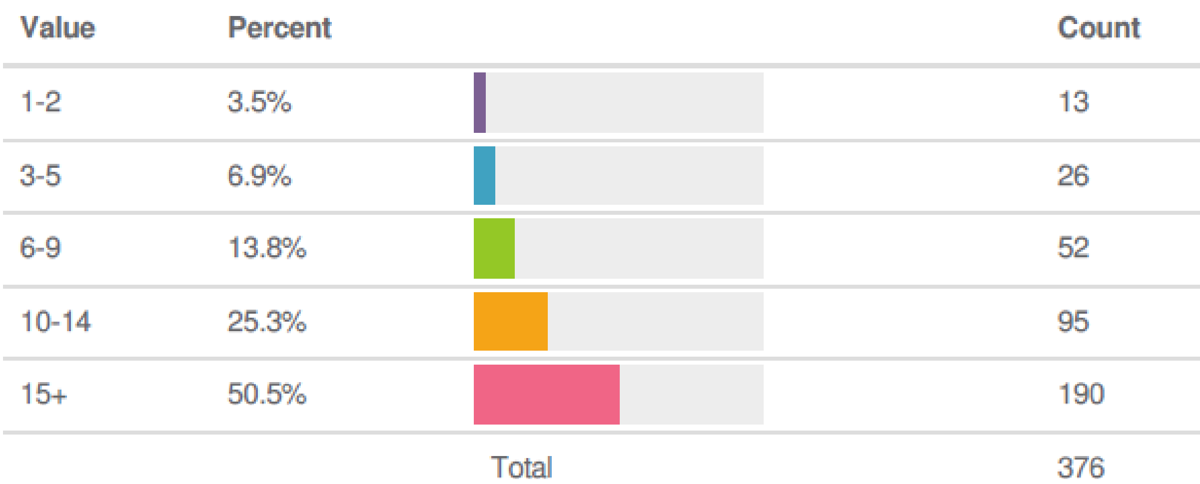


Figure 16. Current Position (Respondents mark all that apply)

The target audience that would benefit from the findings of this survey would be teachers (and coaches), so the greatest response from these groups was appropriate.

To determine if there was strong representation of responses from different grade bands tested on the Smarter Balanced Summative test (3-5, 6-8 and high school), respondents indicated the grade level taught. The elementary grade band of 3-5 represented 44% of the responses with an additional 1.6% from grades pre-kindergarten thru 2nd grade. Respondents in grades 6-8 contributed 24.1% of the responses with high school representing 30.3%. This spread of percentages provided a good representation from all levels.

To determine representation of varying levels of teaching experience, respondents provided years of experience in teaching mathematics. Figure 17 displays this information. Over half of the respondents had 15 or more years of teaching experience with only a small percentage (3.5%) being very new to teaching with 1-2 years of experience.



Value	Percent		Count
1-2	3.5%		13
3-5	6.9%		26
6-9	13.8%		52
10-14	25.3%		95
15+	50.5%		190
		Total	376

Figure 17. Years of Experience Teaching Mathematics

Although there is greater representation from the more experienced group (15+ years), there still appears to be adequate representation from all experience levels.

In addition to reporting the number of years of teaching, respondents indicated their background in mathematics. The percentages of the respondent group is displayed in Figure 18.

Value	Percent	Count
Bachelor's in Math/Math Ed	0.3%	1
Master's in Math/Math Ed	21.8%	82
Doctorate in Math/Math Ed	0.5%	2
Endorsed in Math (without degree)	24.5%	92
National Board Certified in Math	10.6%	40
Other	31.9%	120
	Total	376

Figure 18. Degrees/Certifications Held in Mathematics

Although the “Other” category contained nearly one-third of the total responses, many elementary teachers hold degrees outside of mathematics. With 44% of the respondents indicating teaching experience in the elementary grade band, the nearly one-third response rate is reasonable. The responses from this group were needed to provide insightful information about teacher familiarity and use of resources in grades 3-5. More than half of the respondents had either degrees, certifications or endorsements in mathematics which provided a strong background for evaluating mathematics resources and useful feedback.

Limitations

Although the survey provided good information for next steps in supporting teachers, the help that could be offered to teachers was limited mainly to resource development. Many of the survey responses requested providing additional training on the resources or for extra staff time to explore and understand the resources. Although OSPI, at times, does provide direct training to teachers (for example during the regional trainings using the Item Specification documents), because of time and issues of equity (supporting all teachers verses some) OSPI can only provide limited opportunities for direct training. However, the resources developed are and/or can be utilized by the Regional Mathematics Coordinators (RMCs), other ESD staff, and the OSPI teaching and learning staff during professional development activities and webinars to support teacher development. Additionally, school districts have the responsibility to arrange professional development time for their staff. So, although this may be a requested support, the requested time would need to be provided by schools and districts directly rather than mandated by the state.

Conclusion

The vision for every student in Washington is to be ready for career, college, and life (Office of Superintendent, September 2015). Washington teachers have the responsibility to prepare students to fulfill this vision. With the implementation of the Mathematics K-12 Learning Standards and measurement of those standards by the Smarter Balanced assessments in mathematics, the need to support classroom instruction through teacher support was evident. Surveying teachers to determine their needs in understanding and utilizing Smarter Balanced-developed and state-developed resources, provided useful input into next steps to provide guidance and support for classroom instruction.

The response to the survey that was sent out to mathematics educators in Washington in the spring of 2015 indicated that teachers were interested in providing input to express their needs for support. Many resources were available to teachers, but many teachers were not aware of their existence or found the resources too dense to be helpful. OSPI mathematics assessment staff took this information, revised the presentation of the resources for easier access, and provided more concise and supplemental supports to address teacher needs as expressed in the survey. In moving forward, the hope is that these resources will be better utilized to support classroom instruction to increase student understanding of the standards and better prepare Washington students for career, college, and life.

Recommendations

In Knowles' Principles of Andragogy, adult learners need to be active participants in the planning and evaluation of their instruction. The input that teachers provided was invaluable in helping to design the resources and support for mathematics instruction that would be useful and fulfill teacher and student needs. Because of the considerable teacher response and the impact that had on the redesign of the mathematics resources on the OSPI website, sharing the construction of the redesign with other content areas at OSPI is a recommended next step to help bring alignment to the website resources and to aid educator access. Additionally, assessment staff working closely with the teaching and learning staff is needed to increase the opportunity that professional development through ESDs and districts will utilize the newly created and updated resources.

The assessments resources that were developed are only a starting point in providing support to teachers for classroom instruction. As the Smarter Balanced Assessment Consortium continues its work of providing additional resources, Washington's OSPI Mathematics Assessment staff must determine how to modify and adjust the developed resources to further enhance and supplement those provided by the consortium. The opportunity to partner with state educators in soliciting feedback to direct next steps for support is a cycle that can and should be utilized in future work. Although correspondence has gone out to field about the availability of resources, greater effort must be made to inform the field of the existence of the resources and how they can be utilized to support classroom instruction.

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Appendix A

Survey

Introduction
Thank you for taking the time to complete this survey. Our intent is to provide support to teachers in using assessment resources to inform classroom instruction. Your input is invaluable in this process. Please forward to colleagues who could also provide useful feedback.

Applicant Information

1) Work Information

ESD Region*____________________

School District___________________

Education

2) What degrees/certifications do you hold in mathematics?*
[ ] Bachelor's in Math/Math Ed

[ ] Master's in Math/Math Ed

[ ] Doctorate in Math/Math Ed

[ ] Endorsed in Math (without degree)

[ ] National Board Certified in Math

[ ] Other: ____

Participant Background Information

3) Current Position—please mark all that apply. *
[ ] Classroom Teacher

[ ] Mathematics Coach

[ ] ESD Staff

[ ] District Administrator

[ ] Building Administrator

[ ] Higher Education

[ ] OSPI Math Fellow

[ ] State Network of Education (SNE) Member

[ ] Other (Please Specify): ____

4) Please indicate the grade level you teach.*
( ) P-2

( ) 3-5

( ) 6-8

( ) High School

5) How many years of experience do you have teaching mathematics?*
( ) 1-2

( ) 3-5

( ) 6-9

( ) 10-14

( ) 15+

6) Please indicate your experience with state-level committee work.
[ ] Item Writing

[ ] Content Review

[ ] Rangefinding

[ ] Data Review

[ ] Scoring

[ ] Other: ____

7) Please describe any experience you have working with Smarter Balanced committees or item development.____

Mathematics Standards Experience

8) Please rate, on a scale of 1 (Not at all) to 5 (Completely), your experience with the Washington State K–12 Learning Standards for mathematics (formerly called the Common Core State Standards for Mathematics and referred to as the standards).

	Not at all	2	3	4	Completely
I have studied the standards for the grade level(s) I teach.	( )	( )	( )	( )	( )
My classroom instruction is aligned with the standards.	( )	( )	( )	( )	( )

I could deliver training on the standards.	( )	( )	( )	( )	( )

Progressions Documents

9) Please select which of the following best describes your experience with the Progressions Documents:*
( ) 1-Not aware of them ( ) 2-Aware but not currently using ( ) 3-Reviewed and intend to use
( ) 4-Used the resource periodically to support instruction ( ) 5-Used the resource consistently to support instruction

10) If you have selected a 2 or 3, please choose any of the following which may have been barriers using this resource:
[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

11) How can OSPI support you in utilizing this resource to support classroom instruction?
____

12) If you have selected a 4 or 5 or, in what way did you use this resource to support your instruction? ____

Digital Library

13) Please select which of the following best describes your experience with the Digital Library:*
( ) 1-Not aware of it ( ) 2-Aware but not currently using ( ) 3-Reviewed and intend to use
( ) 4-Used the resource periodically to support instruction ( ) 5-Used the resource consistently to support instruction

14) If you have selected a 2 or 3, please choose any of the following which may have been barriers using this resource:
[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

15) How can OSPI support you in utilizing this resource to support classroom instruction? ____

16) If you have selected a 4 or 5, in what way did you use this resource to support your instruction? ____

17) Were there specific units/resources within the Digital Library that were more helpful? Which ones, and why? ____

Claim Distribution Documents

18) Please select which of the following best describes your experience with the Claim Distribution Documents:*
( ) 1-Not aware of them ( ) 2-Aware but not currently using ( ) 3-Reviewed and intend on using ( ) 4-Used the resource periodically to support instruction ( ) 5-Used the resource consistently to support instruction

19) If you have selected a 2 or 3, please choose any of the following which may have been barriers using this resource:

[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

20) How can OSPI support you in utilizing this resource to support classroom instruction? ____

21) If you have selected a 4 or 5, what recommendations would you have for others using this resource? ____

Item Specification Documents

22) Please select which of the following best describes your experience with the Item Specification Documents:*
( ) 1-Not aware of them ( ) 2-Aware but not currently using ( ) 3-Reviewed and intend on using ( ) 4-Used the resource periodically to support instruction ( ) 5-Used the resource consistently to support instruction

23) If you have selected a 2 or 3, please choose any of the following which may have been barriers using this resource:

[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

24) How can OSPI support you in utilizing this resource to support classroom instruction? ____

25) If you have selected a 4 or 5, what recommendations would you have for others using this resource? ____

Claims Videos

26) Please select which of the following best describes your experience with the Claims Videos:*
( ) 1-Not aware of them ( ) 2-Aware but not currently using ( ) 3-Reviewed and intend on using ( ) 4-Used the resource periodically to support instruction ( ) 5-Used the resource consistently to support instruction

27) If you have selected a 2 or 3, please choose any of the following which may have been barriers using this resource:

[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

28) How can OSPI support you in utilizing this resource to support classroom instruction?
____

29) If you have selected a 4 or 5, what recommendations would you have for others using this resource? _______________________________________

Interim Assessment Blocks (IAB)

30) Please select which of the following describes your experience with the Interim Assessment Blocks (IABs):*
( ) 1-Not aware or do not intend using this resource ( ) 2-Intend using this resource ( ) 3-Have used this resource

31) If you have selected a 1 or 2, please choose any of the following which may have been barriers using this resource:
[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

32) How can OSPI support you in utilizing this resource to support classroom instruction?
____

33) If you have selected a 3, in what way did you use this resource to support your instruction?
____

Interim Comprehensive Assessment (ICA)

34) Please select which of the following describes your experience with the Interim Comprehensive Assessment (including Teacher Hand Scoring System - THSS):*
( ) 1-Not aware or do not intend using this resource ( ) 2-Intend using this resource ( ) 3-Have used this resource

35) If you have selected a 1 or 2, please choose any of the following which may have been barriers using this resource:

[ ] Not enough time

[ ] Found other resources more useful

[ ] Resource is difficult to use

[ ] School/district efforts have focused in other areas (e.g., TPEP)

[ ] Resource is difficult to access

[ ] Unsure of how to use this resource to support instruction

[ ] Other: ____

36) How can OSPI support you in utilizing this resource to support classroom instruction?

____

37) If you have selected a 3, in what way did you use this resource to support your instruction?

____

Additional Questions

38) What other materials or resources have you used and/or found helpful that support classroom instruction to prepare students for the summative tests? In what ways were they helpful?

____

39) How can OSPI better communicate information to the field? _______________________

*Required Item

Appendix B

Achievement Level Descriptors (ALDs) – Sample from High School

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

Smarter Balanced Assessments
Smarter Balanced assessments in English language arts (ELA) and mathematics are administered to students in grades 3–8 and high school. Smarter Balanced Achievement Level Descriptors (ALDs) were developed by K–12 teachers and administrators and higher education faculty from the Smarter Balanced Governing States. The ALDs are aligned to the academic level colleges expect students to have when they arrive on campus. The ALDs describe the knowledge, skills, and processes that students demonstrate on state tests in each performance level, at each tested grade level.

Range ALDs:
Grade- and content-specific descriptions of the cognitive and content rigor encompassed within each achievement level. The range ALDs describe the knowledge, skills, and processes *typical* of students in each achievement level.

The Range ALDs presented in this document represent a new direction in the focus and purpose of ALDs. In the past, ALDs were developed near the end of the test development cycle and could only summarize student performance. This new approach allows for the development of ALDs at the beginning of the test development cycle so that expectations for student performance may guide the way tests are conceived and produced.

The Range ALDs presented in this document are identical to the Smarter Balanced ALDs. We have extracted the Claim 1 Range ALDs and bulleted them for ease of reading. The Claims 2, 3, and 4 Range ALDs have also been extracted and formatted by removing the assessment targets for those claims.

It is important to note that this document is not intended to be used as a checklist. This is especially true for the high school ALDs which do not describe all of the content in the Standards that students should be learning. The ALDs should, instead, be used to inform educators regarding the typical skills and knowledge a student in each achievement level (Level 1, 2, 3, and 4) is likely to have. They can also be used to inform educators of the skills and knowledge required for students to perform at Levels 3 and 4, levels that show students are making adequate progress toward career- and college-ready skills.

Any questions about this document can be sent to mathematics@k12.wa.us. Thank you.

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

Achievement level descriptors (ALDs) describe student performance on a standardized test in terms of levels or categories of performance. For the Smarter Balanced assessments, outcomes will be reported in terms of four levels of achievement: Level 1, Level 2, Level 3, and Level 4. The ALDs are text descriptions of the knowledge, skills, and processes that are expected to be demonstrated by students in each category of performance.

CLAIM 1: Students can explain and apply mathematical concepts and carry out mathematical procedures with precision and fluency.

	Level 1 students should be able to:	Level 2 students should be able to:	Level 3 students should be able to:	Level 4 students should be able to:
Target D: Interpret the structure of expressions.	• Identify parts of an expression, such as terms, factors, coefficients, exponents.	• Interpret parts of an expression, such as terms, factors, coefficients, exponents, etc., and interpret simple compound expressions by viewing one or more of their parts as a single entity. • Recognize equivalent forms of linear expressions.	• Recognize equivalent forms of expressions and use the structure of an expression to identify ways to rewrite it. • Interpret complicated expressions by viewing one or more of their parts as a single entity.	• Look for and use structure and repeated reasoning to make generalizations about the possible equivalent forms expressions can have, e.g., a quadratic expression can always be represented as the product of two factors containing its roots.
Target E: Write expressions in equivalent forms to solve problems.	• Write a quadratic expression with integer coefficients and a leading coefficient of 1 in an equivalent form by factoring. • Use properties of exponents to expand a single variable (coefficient of 1) with a positive integer exponent into an equivalent form and vice versa, e.g., $x^3 = xxx$.	• Write a quadratic expression with integer coefficients in an equivalent form by factoring or by completing the square. • Use properties of exponents to expand a repeated single variable (coefficient of 1) with a nonnegative integer exponent into an equivalent form and vice versa, e.g., $x^0x^2x^3 = xxxxx = x^{2+3}$.	• Write a quadratic expression with rational coefficients in an equivalent form by factoring and by completing the square. • Identify and use the zeros to solve or explain familiar problems. • Use properties of exponents to write equivalent forms of exponential functions with one or more variables, integer coefficients, and nonnegative rational exponents involving operations of addition, subtraction, and multiplication, including distributing an exponent across terms within parentheses.	• Find the maximum or minimum values of a quadratic function. • Choose an appropriate equivalent form of an expression in order to reveal a property of interest when solving problems.
Target F: Perform arithmetic operations on polynomials.	• Add, subtract, and multiply single-variable polynomials of degree 2 or less.	• Add, subtract, and multiply multi-variable polynomials made up of monomials of degree 2 or less. • Understand that polynomials are closed under addition.	• Add, subtract, and multiply multi-variable polynomials of any degree. • Understand that polynomials are closed under subtraction and multiplication.	• Understand and be able to explain that polynomials form a system analogous to the integers.

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

Target G: Create equations that describe numbers or relationships.	• Create and use one-step linear equations in one variable to model a familiar situation and to solve a familiar problem.	• Create and use quadratic equations, linear equations, and linear inequalities in one and two variables to model a familiar situation and to solve a familiar problem • Graph a linear or a quadratic equation in two variables and be able to rearrange a familiar formula or an unfamiliar linear formula in one or two variables for a particular given quantity.	• Create and use linear, quadratic, and rational equations and inequalities and exponential equations with an integer base and a polynomial exponent in multiple variables to model an unfamiliar situation and to solve an unfamiliar problem. • Graph an equation in two variables and be able to rearrange a linear, a quadratic, an absolute, a rational, or a cubic multi-variable formula for a particular given quantity.	• Rearrange polynomial, logarithmic, exponential, or trigonometric formulas with one or more variables to highlight a quantity of interest and be able to analyze in context to determine which quantity is of interest.
Target H: Understand solving equations as a process of reasoning and explain the reasoning.	• Explain solution steps for solving one-step linear equations in one variable.	• Look for and make use of structure to solve simple radical equations and simple rational equations in one variable in which the variable term is in the numerator and should understand the solution steps as a process of reasoning. • Understand and explain solution steps for solving linear equations in one variable as a process of reasoning.	• Look for and make use of structure to solve simple radical and rational equations in one variable presented in various forms. • Understand and explain solution steps for solving quadratic, radical, and rational equations in one variable as a process of reasoning.	• Give examples showing how extraneous solutions may arise and why they arise when solving linear, quadratic, radical, and rational equations.
Target I: Solve equations and inequalities in one variable.	• Solve one-step linear equations in one variable.	• Solve one-step linear inequalities and quadratic equations in one variable with integer roots.	• Solve multi-step linear equations and inequalities and quadratic equations in one variable with real roots.	• Solve quadratic equations in one variable with complex roots.
Target J: Represent and solve equations and inequalities graphically.	• Represent a linear equation with an integer-valued slope in two variables graphically on a coordinate plane.	• Represent linear equations and inequalities and quadratic equations with integer coefficients in one and two variables graphically on a coordinate plane and should understand that the plotted line or curve represents the solution set to an equation • Graph and estimate the solution of systems of linear equations.	• Represent polynomial, rational, absolute value, exponential, and logarithmic functions graphically. • Graph and estimate the solution of systems of equations and systems of linear inequalities. • Understand that the plotted line, curve, or region represents the solution set to an equation or inequality.	• Explain why the *x*-coordinates of the points where $f(x)$ and $g(x)$ intersect compose the solution to $f(x) = g(x)$.

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

Target K: Understand the concept of a function and use function notations.	• Distinguish between functions and non-functions. • State the domain and range given a graph.	• Understand the concept of a function in order to distinguish a relation as a function or not a function. • Identify domain and range of a function given a graph of a quadratic, linear, cubic, or absolute function. • Understand that the graph of a function $f(x)$ is the graph of the equation $y = f(x)$.	• Use function notation to evaluate a function given in function notation for a particular input. • Identify the domain and range for any given function presented in any form, e.g., as a graph, a verbal description, or a sequence.	• Find the input for a given output when given in function notation.
Target L: Interpret functions that arise in applications in terms of a context.	• Interpret linear functions in context, and given the key features of a linear graph, they should be able to identify the appropriate graph.	• Interpret quadratic and other polynomial functions in two variables in context of the situation, and given the key features of a graph of a polynomial function, they should be able to identify the appropriate graph. • Specify the average rate of change from an equation of a linear function and approximate it from a graph of a linear function.	• Graph various types of functions and interpret and relate key features, including range and domain, in familiar or scaffolded contexts. • Specify the average rate of change of a function on a given domain from its equation or approximate the average rate of change of a function from its graph.	• Interpret complex key features such as holes, symmetries, and end behavior of graphs and functions in unfamiliar problems or contexts.
Target M: Analyze functions using different representations.	• Graph a linear function by hand or by using technology. • Compare properties of two linear functions represented in different ways. • Identify equivalent forms of linear functions.	• Graph linear and quadratic functions by hand. • Graph square root, cube root, piecewise-defined, polynomial, exponential, and logarithmic functions by hand or by using technology. • Compare properties of two quadratic or two other functions of the same type, i.e., linear to linear, represented in different ways. • Understand equivalent forms of linear and quadratic functions. • Compare properties of two trigonometric functions represented in the same way.	• Analyze and compare properties of two functions of different types represented in different ways and understand equivalent forms of functions. • Graph trigonometric functions by hand and by using technology.	• Graph a variety of functions, including linear, quadratic, square root, cube root, piecewise-defined, polynomial, exponential, logarithmic, and trigonometric, by hand and by using technology. • Analyze and explain relationships between various types of functions and the behaviors of the functions and be able to determine which equivalent form is most appropriate for a given task.

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

Target N: Build a function that models a relationship between two quantities.	• Identify an explicit or a recursive function and determine the steps for calculation from a context requiring up to two steps. • Add and subtract two linear functions.	• Build an explicit or a recursive function to describe or model a relationship between two quantities and determine the steps for calculation from a context. • Add, subtract, and multiply linear and quadratic functions.	• Translate between explicit and recursive forms of a function. • Add, subtract, multiply, and divide functions.	• Determine when it is appropriate to combine functions using arithmetic operations in context.
Target P: Summarize, represent, and interpret data on a single count or measurement variable.	• Describe a data set in terms of center and spread and represent data graphically.	• Describe and use appropriate statistics to interpret and explain differences in shape, center, and spread of two or more different data sets, including box plots, histograms, or dot plots, representing familiar contexts. • Identify the mean and the median and select the appropriate one for representing the center of the data for data sets.	• Use appropriate statistics to interpret, explain, and summarize differences in shape, center, and spread of two or more different data sets of varying complexity and levels of familiarity, including the effect of outliers. • Select the appropriate choice of spread as interquartile range or standard deviation based on the selection of center and use the standard deviation of a data set to fit to a normal distribution.	• Interpret data to explain why a data value is an outlier and interpret and explain differences in the approximate areas under the normal curve of two or more data sets.
Target C: Reason quantitatively and use units to solve problems.	• Choose the units in a formula, correctly scale a graph with unit increments, and identify a quantity from a graph with a scale in unit increments of a specified measurement.	• Reason quantitatively to choose and interpret the units in a formula given in a familiar context, including making measurement conversions between simple units and identifying a quantity from a graph with the scale in increments of various sizes. • Use units to guide the solution of a familiar multi-step problem with scaffolding.	• Reason quantitatively to choose and interpret the units in a formula given in an unfamiliar context, including making measurement conversions between compound units, and to define appropriate quantities or measurements in familiar contexts with some scaffolding to construct a model. • Identify appropriate levels of measurement precision in context and to choose and interpret the scale and origin of a graph or data display. • Use units to guide the solution of an unfamiliar multi-step problem without scaffolding.	• Define appropriate quantities or measurements in unfamiliar contexts with little to no scaffolding to construct a model.

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

Target A: Extend the properties of exponents to rational exponents.	• Rewrite expressions with rational exponents of the form (1/*n*) to radical form and vice versa.	• Look for and use structure to extend the properties of integer exponents to multiply and divide expressions with rational exponents that have common denominators.	• Rewrite expressions with rational exponents of the form (*m*/*n*) to radical form, and vice versa, and look for and use structure to extend the properties of integer exponents to all laws of exponents on radical expressions and expressions with rational exponents.	• Identify the exponent property used when rewriting expressions and recognize when laws of exponents cannot be used to rewrite an expression.
Target B: Use properties of rational and irrational numbers.	• Identify the difference between a rational and an irrational number.	• Perform operations on rational and irrational numbers. • Look for and use repeated reasoning to understand that the rational numbers are closed under addition and multiplication.	• Look for and use repeated reasoning to understand and explain that the sum and product of a rational number and a nonzero irrational number are irrational.	• Provide a specific example given a generalization statement, such as the sum of a rational number and an irrational number is irrational.
Target O: Define trigonometric ratios and solve problems involving right triangles.	• Identify trigonometric ratios and use the Pythagorean Theorem to solve for the missing side in a right triangle in familiar real-world or mathematical contexts with scaffolding.	• Define trigonometric ratios. • Know the relationship between the sine and cosine of complementary angles. • Use the Pythagorean Theorem in unfamiliar problems and trigonometric ratios in familiar problems to solve for the missing side in a right triangle with some scaffolding.	• Use the Pythagorean Theorem, trigonometric ratios, and the sine and cosine of complementary angles to solve unfamiliar problems with minimal scaffolding involving right triangles, finding the missing side or missing angle of a right triangle.	• Solve unfamiliar, complex, or multi-step problems without scaffolding involving right triangles.

Achievement Level Descriptors (ALDs) for Summative Smarter Balanced Assessment for High School Mathematics

CLAIM 2: Students can solve a range of complex, well-posed problems in pure and applied mathematics, making productive use of knowledge and problem-solving strategies.
CLAIM 4: Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.

	Level 1 students should be able to:	Level 2 students should be able to:	Level 3 students should be able to:	Level 4 students should be able to:
	• Identify important quantities in the context of a familiar situation and translate words to equations or other mathematical formulation. • When given the correct math tool(s), be able to apply the tool(s) to problems with a high degree of scaffolding. • Apply mathematics to solve familiar problems arising in everyday life, society, and the workplace by identifying important quantities and by beginning to develop a model.	• Identify important quantities in the context of an unfamiliar situation and to select tools to solve a familiar and moderately scaffolded problem or to solve a less familiar or a non-scaffolded problem with partial accuracy. • Provide solutions to familiar problems using an appropriate format (e.g., correct units, etc.). • Interpret information and results in the context of a familiar situation. • Apply mathematics to propose solutions by identifying important quantities, locating missing information from relevant external resources, beginning to construct chains of reasoning to connect with a model, producing partial justification and interpretations, and beginning to state logical assumptions.	• Map, display, and identify relationships, use appropriate tools strategically, and apply mathematics accurately in everyday life, society, and the workplace. • Interpret information and results in the context of an unfamiliar situation. • Apply mathematics to solve unfamiliar problems arising in everyday life, society, and the workplace by identifying important quantities and mapping, displaying, explaining, or applying their relationship and by locating missing information from relevant external resources. • Construct chains of reasoning to justify a model used, produce justification of interpretations, state logical assumptions, and compare and contrast multiple plausible solutions.	• Analyze and interpret the context of an unfamiliar situation for problems of increasing complexity and solve problems with optimal solutions. • Apply mathematics to solve unfamiliar problems by constructing chains of reasoning to analyze a model, producing and analyzing justification of interpretations, stating logical assumptions, and constructing and comparing/contrasting multiple plausible solutions and approaches.

CLAIM 3: Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.

	Level 1 students should be able to:	Level 2 students should be able to:	Level 3 students should be able to:	Level 4 students should be able to:
	• Base arguments on concrete referents such as objects, drawings, diagrams, and actions and identify obvious flawed arguments in familiar contexts.	• Find and identify the flaw in an argument by using examples or particular cases. • Break a familiar argument given in a highly scaffolded situation into cases to determine when the argument does or does not hold.	• Use stated assumptions, definitions, and previously established results and examples to test and support their reasoning or to identify, explain, and repair the flaw in an argument. • Break an argument into cases to determine when the argument does or does not hold.	• Use stated assumptions, definitions, and previously established results to support their reasoning or repair and explain the flaw in an argument. • Construct a chain of logic to justify or refute a proposition or conjecture and to determine the conditions under which an argument does or does not apply.

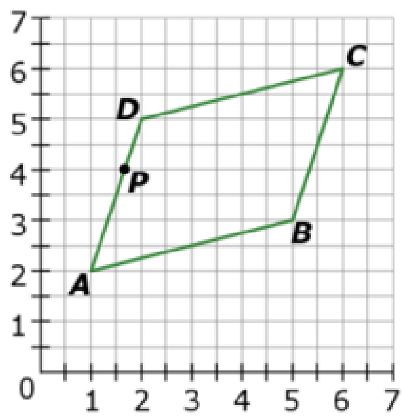
Appendix C

Cluster Quiz – Applications in Geometry

Sample from High School

Applications in Geometry

1. Parallelogram *ABCD* has vertices *A*(1, 2), *B*(5, 3), *C*(6, 6), and *D*(2, 5). Point *P* is located on $\overline{AD}$ at $(1\frac{2}{3}, 4)$. Point *Q* lies on $\overline{BC}$ such that $\overline{PQ}$ is parallel to $\overline{AB}$.



Write an ordered pair to represent the location of Point *Q*.

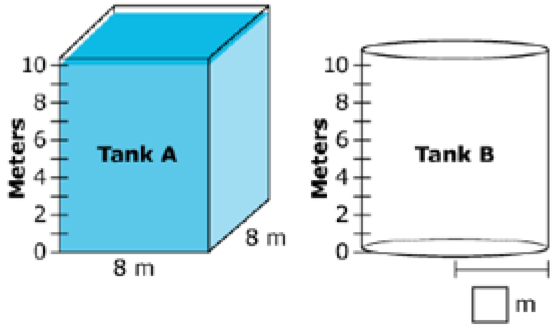
2. Line *m* can be represented by the equation $3x - 6y = 18$.

Write an equation of the line perpendicular to line *m* that passes through the point (–4, 1).

3. What is the slope of a line perpendicular to $2x + 3y = 6$?

A. $-\frac{3}{2}$
B. $-\frac{2}{3}$
C. $\frac{2}{3}$
D. $\frac{3}{2}$

4. Two water tanks are shown. Tank A is a rectangular prism and Tank B is a cylinder. The tanks are not drawn to scale.

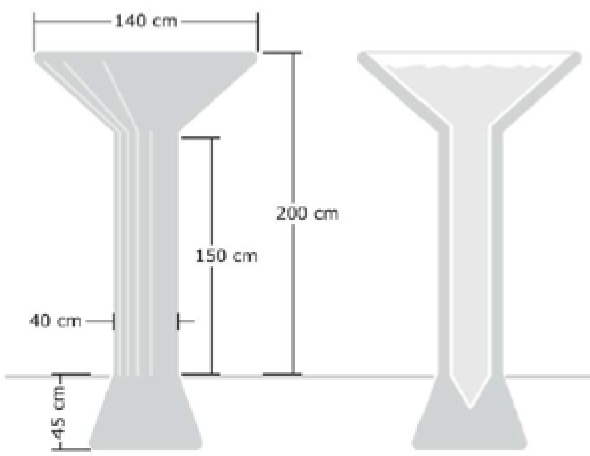


Tank A is filled with water to the 10-meter mark.

Half of the water from Tank A is then poured into Tank B. The water level on Tank A drops to 5 meters and the water level on Tank B becomes 4 meters.

What is the radius of the base of Tank B, to the nearest meter?

5. The dimensions and a cross section of a rainwater cistern are shown in the figure.



If you want to, you may use these conversations and formulas:

1 m = 100 cm	Volume of a sphere: $V = \frac{4}{3}\pi r^3$
1 cm = 10 mm	Volume of a cylinder: $V = \pi r^2 h$
1 cm^3 = 1 mL	Volume of a cone: $V = \frac{1}{3}\pi r^2 h$
1 L = 1000 mL	

Estimate the number of liters (L) of water the cistern can hold when full.

6. Eric is using a shovel to clear the snow from his driveway. He moves 8 shovelfuls of snow each minute. After 60 minutes, Eric states, "I think I have shoveled more than a ton of snow."

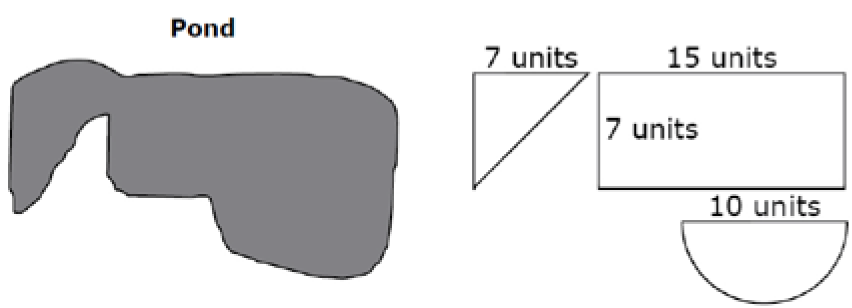
Part A
Estimate the weight of snow that Eric can move with each shovelful.

If you want to, you can use the table of weights of everyday objects below.
A ton is 2000 pounds, and a pound is 16 ounces.

Object	Weight
Basketball	20 ounces
Apple	7 ounces
Bicycle	20 pounds
Car	1.5 tons
Pack of chewing gum	1 ounce

Part B
Use your estimate to decide if Eric's claim is correct or not.

7. A researchers models the area of the surface of a pond using a rectangle, a semi-circle, and a right isosceles triangle.



Explain whether the researcher's model will estimate an area greater than, equal to, or less than the actual area of the pond's surface. Use specific information from the pond and/or model and mathematics to support your answer.

Teacher Material

G-GMD.A
Explain volume formulas and use them to solve problems

G-MG.A
Apply geometric concepts in modeling situations

G-CO.D
Make geometric constructions

G-GPE.A
Translate between the geometric description and the equation for a conic section

Question	Claim	Key/Suggested Rubric
1	1	**1 point:** $(5\frac{2}{3}, 5)$.
2	1	**1 point:** $y = -2x - 7$, or equivalent equation in any form.
3	1	**1 point:** Selects D.
4	2	**1 point:** 5.
5	4	**1 point:** An estimate between 340 and 700.
6	4	**2 points:** A reasonable estimate for Part A (1 pound to 15 pounds) AND a decision for Part B that is consistent with the estimate in Part A (an estimate less than $4\frac{1}{6}$ pounds results in Eric's statements not being correct, and estimates of $4\frac{1}{6}$ pounds or more results in Eric's statements being correct). **1 point:** A reasonable estimate for Part A OR a decision for Part B that is consistent with the estimate in Part A.
7	4	**1 point:** The student determines the model will estimate an area less than the actual area of the pond's surface and provides mathematical support (e.g., the sections of the pond modeled by each figure are larger than the figures in the model).

Appendix D

Critical Questions for the Progressions Documents

Critical Questions for Use with the Progressions Documents for the Mathematics K–12 Learning Standards

The Mathematics K–12 Learning Standards (formerly the Common Core State Standards, also referred to as "the Standards") were built on learning progressions, informed both by research on children's cognitive development and by the logical structure of mathematics. These progression documents describe the cognitive development and structure of mathematics in several important areas of the standards. These documents note key connections among standards, point out cognitive difficulties and pedagogical solutions, and give more detail on particularly knotty areas of the mathematics. These documents are intended to inform teacher preparation programs and professional development, curriculum organization, and textbook content. Thus, their audience includes teachers and anyone involved with schools, teacher education, test development, or curriculum development.

Critical Questions

For each progression document, including the Front Matter document, OSPI staff have developed several critical questions to guide discussions as you read through the documents. This document focuses on progression documents relevant for high school. These questions are not meant to be a "scavenger hunt" of the document, but rather an opportunity to engage in deeper conversation and consideration of the ideas and thoughts presented in the document. We encourage educators to use these questions to guide department, PLC, or staff meeting engagement with and conversations about the Progressions Documents for the Mathematics K–12 Learning Standards. Feedback and clarifying questions on these critical questions are welcome; please send your thoughts to mathematics@k12.wa.us.

Draft Front Matter

1. Why is each audience identified as an important audience for discussions on learning progressions and these progression documents?
2. How can focusing on a small collection of general mathematical properties help students gain a better understanding and facility with mathematics than a large collection of specialized procedures?
3. Since well documented progressions for all of K–12 mathematics do not exist, what process can educators use to inform a learning progression in content for which a progression document does not exist?
4. Why is the inclusion of the Standards for Mathematical Practice important to a learning progression?
5. As the Standards call for educators to approach mathematical concepts differently than many adults experienced them when they were in school, parents and non-educator stakeholders in particular often question the need for and value in a different approach. How can educators communicate the importance of this new approach, including changes such as described in the *Reconceptualized topics; changed notation and terminology* section, to parents and non-educator stakeholders?

Draft High School Progression on Statistics and Probability

1. What approaches will help students distinguish between correlation and causation?
2. How can students use statistical tools to construct and defend logical arguments based on data?
3. What are the key aspects of survey design and sampling that students should understand and be able to apply?

Draft High School Progression on Algebra

1. How are the Standards for Mathematical Practice 7, "Look for and make use of structure," and 8, "Look for and express regularity in repeated reasoning," utilized when building understanding of expressions and equations?
2. How can you develop student understanding of the uses and properties of equivalent forms of expressions?
3. What are strategies to help students develop the skills of solving equations as a process of reasoning?

Draft 8, High School Progression on Functions

1. How does the idea of functions build from pattern standards in the early grades to using functions to model relationships between quantities in high school?
2. How is function notation used to interpret meaning of contexts?
3. How can educators use function families to develop understanding of varying parameters and the effects on graphs and key features of functions?

Draft High School Progression on Modeling

1. How are units utilized in communicating the results of a model in a real-world context?
2. What are some important aspects to keep in mind when building a mathematical model?
3. How are models used to deduce additional information about a real-world situations?

Appendix E

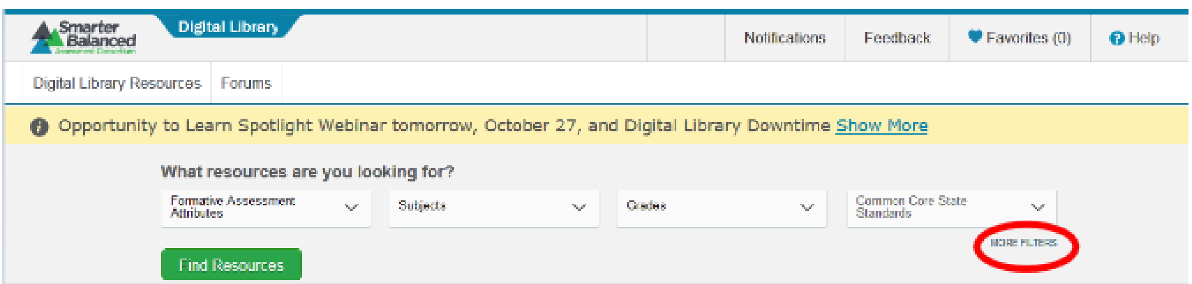
Digital Library Resources Guide – Sample from High School

Digital Library Resources Guide

Digital Library Resources Guide Overview

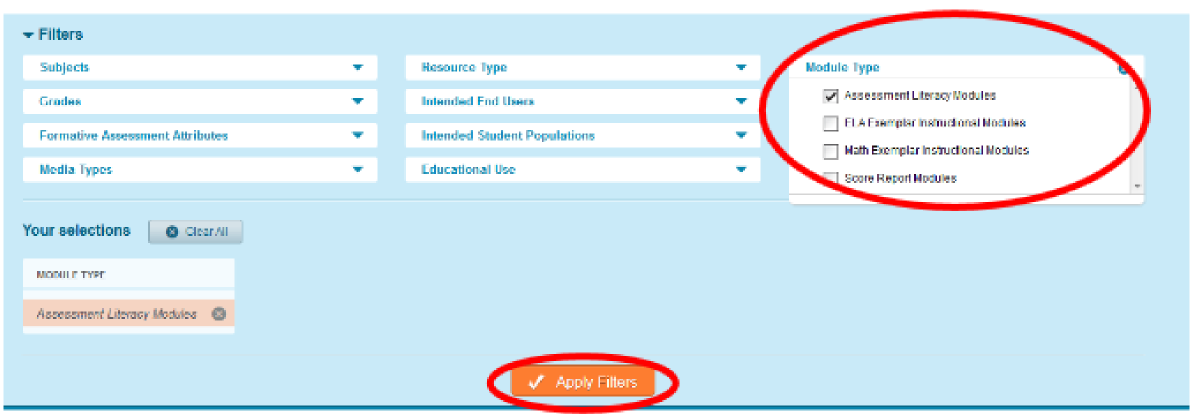
While there are many excellent resources in the Digital Library, this document identifies some suggested modules and resources in grades 8 through high school to guide your exploration into understanding and using formative assessment practices. We recommend that educators new to the Digital Library and/or the formative assessment process start with the Assessment Literacy Modules described on page 2. Educators more familiar with the Digital Library and/or the formative assessment process may prefer to start with the Content Specific Exemplar Instructional Modules, the Illustrative Mathematics Modules, or the Example Resources found on pages 3–4.

First Steps:
To navigate to the Assessment Literacy Modules, select "MORE FILTERS" from the main Digital Library page.



Then, on the "Filter's" page:

1. Click on "Module Type" to show the drop-down menu
2. Click the check the box in front of "Assessment Literacy Modules"
3. Click "Apply Filters."



Digital Library Resources Guide

Assessment Literacy Modules:
These modules are an introduction to the concept of formative assessment and its four component parts. These modules can be used with educators who are accessing the Digital Library for the first time and/or are starting to use formative assessment practices with students. **Of highest importance is the *Understanding the Formative Assessment Process* module**; every educator in Washington should use this module to increase their knowledge of the formative assessment process and practices. We encourage educators to view these modules in department, PLC, or staff meetings, or in other venues that allow for discussion on the topics presented.

Title	Description
Understanding the Formative Assessment Process	**This vitally-important module provides an introduction to and examples of the four attributes in the Formative Assessment Process. The definition and key features of the Formative Assessment process are discussed. The module also explains how effective use of formative assessment improves teaching and learning.**
Clarifying Intended Learning in the Formative Assessment Process	There are four modules with this title, one for each grade band: Grades K–2, Grades 3–5, Grades 6–8, and Grades 9–12. This module describes the first attribute in the Formative Assessment Process with a focus on helping students understand their learning goals and to recognize when they have reached that goal.
Eliciting Evidence in the Formative Assessment Process	There are four modules with this title, one for each grade band: Grades K–2, Grades 3–5, Grades 6–8, and Grades 9–12. This module describes the second attribute in the Formative Assessment Process with a focus on educators gaining knowledge of students' movement toward attaining learning goals.
Interpreting Evidence in the Formative Assessment Process	There are four modules with this title, one for each grade band: Grades K–2, Grades 3–5, Grades 6–8, and Grades 9–12. This module describes the third attribute in the Formative Assessment Process with a focus on connecting the evidence gathered to the standards and a progression of learning.
Acting on Evidence in the Formative Assessment Process	There are four modules with this title, one for each grade band: Grades K–2, Grades 3–5, Grades 6–8, and Grades 9–12. This module describes the fourth attribute in the Formative Assessment Process with a focus on using evidence to inform next steps in a progression of learning.
The Components of Effective Feedback	There are three modules with this title, one for each grade band: Grades K–12, Grades K–5, and Grades 6–12. This module describes three types of feedback (teacher, peer, and student self-reflections), how descriptive feedback is different from evaluative feedback, and how effective, descriptive feedback can be incorporated throughout the Formative Assessment Process.
Students as Partners in Their Own Learning	There are two modules with this title, one for each grade band: Grades K–5 and Grades 6–12. This module describes why engaging students in the Formative Assessment Process is effective in increasing student motivation and self-direction, both of which lead to improved learning.

Digital Library Resources Guide

Content Specific Exemplar Instructional Modules:

These modules dive deeper into the Formative Assessment Process by showing its use with specific content. These modules can be used with educators who understand the Formative Assessment Process (through viewing the Assessment Literacy modules above, for example) and want to begin using it with specific content. These modules can also be used to guide development of lessons that follow the Formative Assessment Process. We encourage educators to view these modules in department, PLC, or staff meetings, or in other venues that allow for discussion on the topics presented.

Grade Band/Level	Title	Description
8	The Pythagorean Theorem	Four modules, one for each formative assessment attribute, that focus on helping students understand the meaning of proof so that students can construct proofs of the Pythagorean Theorem. The teacher uses formative assessment to address a misconception about irrational numbers as possible lengths of line segments.
HS	Geometry Congruence	Four modules, one for each formative assessment attribute, that focus on building on students' previous experience in rigid motion to understand congruence requirements and statements. Students use rigid motions to create congruent figures and are shown that multiple series of motions can be used to show the figures are congruent.
HS	Interpreting Functions	This module focuses on eliciting evidence about students' understanding of functions by using questions at different Depth of Knowledge (DOK) levels.
HS	Building Functions	Four modules, one for each formative assessment attribute, use a real-world example of E. coli bacteria growth on food to develop understanding of building a function to model a situation.

Illustrative Mathematics Module:

This module represents a series of lessons that goes deeper than individual lessons shown in the Content Specific Exemplar Instructional Modules list above. This module was created by a team from Illustrative Mathematics in collaboration with The Teaching Channel and Desmos and provide a wide variety of resources for using the Formative Assessment Process with specific high school content. This module can be used with educators as they work to more fully incorporate the Formative Assessment Process in units of instruction. This module can also be used to develop a unit of instruction that uses the formative assessment process and practices. We encourage educators to view, discuss, and use this module in department, PLC, or staff meetings, or in other venues that allow for discussion of how best to use this module to inform units and lessons of instruction.

Grade Band/Level	Title	Description
HS	Illustrative Mathematics Modeling HS-F Module	This collection of work traces mathematical ideas in the standards in the HS-F.IF.B cluster, with an emphasis on modeling, through professional learning, classroom materials, and teacher reflection. Included in this collection are a series of instructional tasks, professional development resources, and videos of professional development around the idea of collaborative lesson planning, evaluation, and refinement.

Digital Library Resources Guide

Example Resources at Grade Levels:

The Digital Library contains thousands of resources from which educators can build units and lessons of instruction that use the Formative Assessment Process; educators are free to do so with any module in the Digital Library. These example resources represent potential starting points for educators in that process. This is not meant to be an exhaustive list of the content students should be learning or practices that are effective. We encourage educators to view, discuss, and use these and other Digital Library resources in department, PLC, or staff meetings, or in other venues that allow for the development of units and lessons of instruction.

Grade Level	Title	Description
8	Game Design: Using Congruence Transformations	In this open-ended task using content in standards in the 8.G.A cluster, students create and analyze a game that uses a variety of transformations of figures to satisfy a list of criteria.
8	Scatter Plot and Best Fit Line Project	This resource is an activity, aligned to standards in the 8.SP.A cluster, where students work in groups of three to select a data topic and create a scatter plot of given data and then analyze it by finding the best fit line and then finding the slope and its correlation.
HS	Interpreting the Structure of Equations	This lesson, based on content in A-REI.B, allows students to sort quadratic equations based on the method they think would be best to solve. Teachers can work with the whole class or have students work individually, in partners, or small groups.
HS	End Behavior and Vertical/Horizontal Shift of Functions	Aligned to content in F-IF.C, this activity can be used after an introduction to the several different types of functions students study in high school. Opportunities exist for students to model the functions kinesthetically, helping them deepen their understanding of behaviors of different function families.
HS	Designing the Optimal Can	This is a performance task where students demonstrate their mastery of volume and surface area of a cylinder, using concepts aligned to G-GMD.A and G-MG.A. Students find the dimension of a cylindrical can with a given volume that use the least amount of aluminum.
HS	Understanding Samples	Aligned to content in S-IC.B, this 5-question activity can help educators gauge their students' understanding of sampling and sampling distributions to direct instruction on those topics.

Appendix F

GovDelivery Message – Communication about New Resources

Updated Mathematics Assessment Webpage – Please Visit!

Welcome to the new year, 2016! The OSPI mathematics team has redesigned the mathematics assessment webpage to present resources by grade level, and we've also added several new resources. We encourage you to visit this redesigned page and check out the new resources. Of special note are:

- Achievement Level Descriptors (ALDs) describing student performance for each of the four Smarter Balanced achievement levels.
- Grade-level-specific Claim Distribution documents for the Smarter Balanced Tests.
- Guidance for incorporating the very important Common Core Progressions documents into a PLC, department workgroup, and/or school workgroups.
- Selected Digital Library resources to help implement formative assessment in your classroom and school.
- Paper-pencil quizzes organized by cluster, conceptual category, and Smarter Balanced assessment claim.

We hope these resources will be valuable as you move students toward developing the key conceptual, procedural, and process skills described in the Mathematics K–12 Learning standards. Questions? Email questions and comments to us at any time.

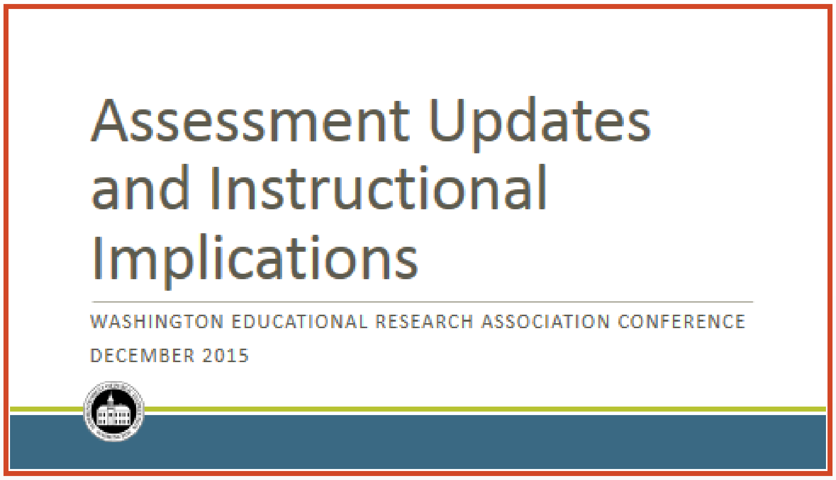
The OSPI mathematics team

Appendix G

Washington Educational Research Association (WERA)

Conference Presentation Excerpt from 2015

1



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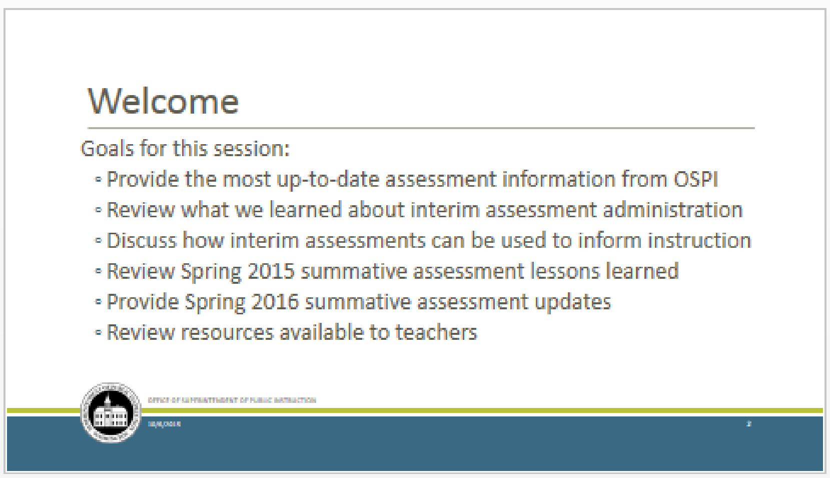


3

4

Interim Assessment Purposes

- Check student progress
  - Progress with specific content (interim blocks)
  - Progress toward end-of-year goals (interim comprehensive)
- Provide information to inform instruction
- Familiarize students with online testing

5

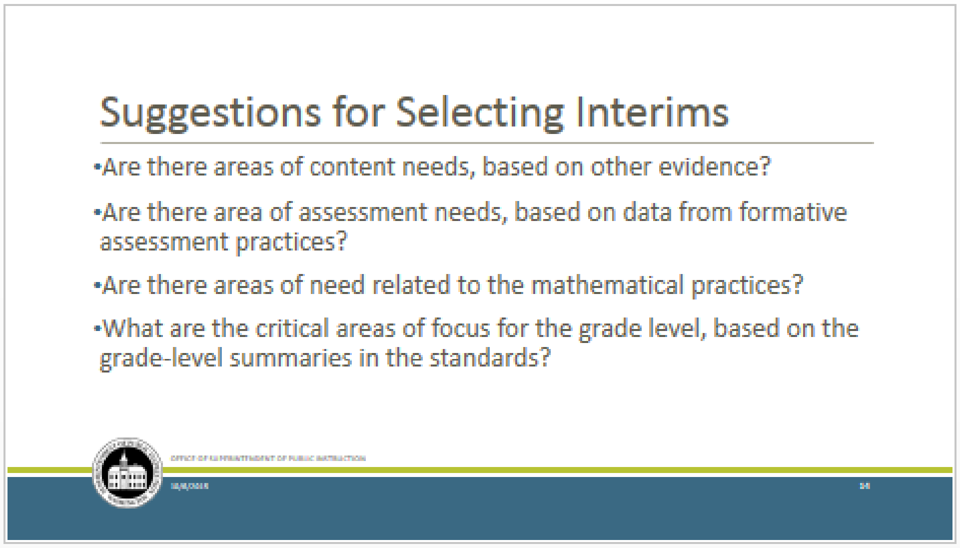
Interim Comprehensive Assessment (ICA)

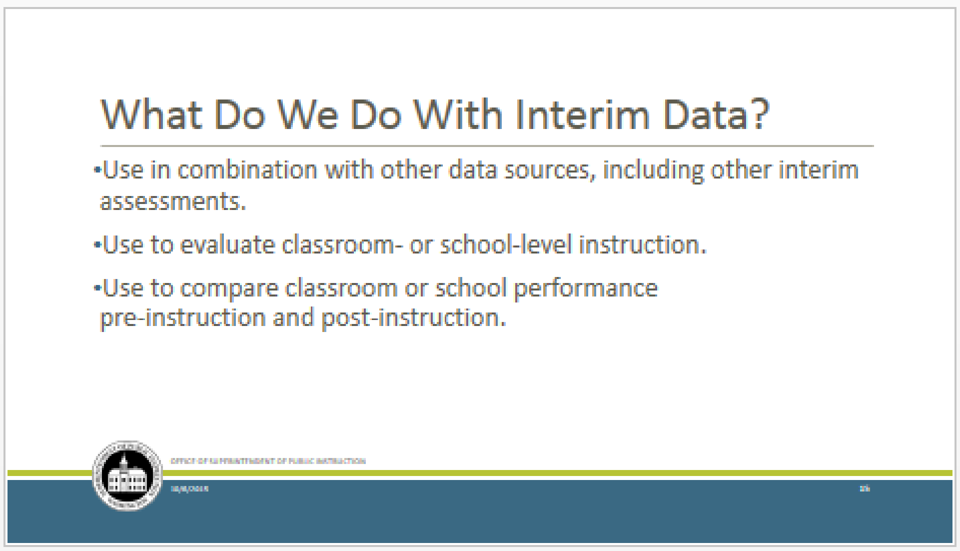
- Same blueprint as the summative assessment. (Available in "General Information" folder on the WCAP Portal)
- Includes both a "CAT" portion and a Performance Task (PT).
  - "CAT" portion not currently computer-adaptive.
  - Both "CAT" and PT need to be completed for reports to generate in ORS.
- Requires hand scoring prior to reports in ORS.

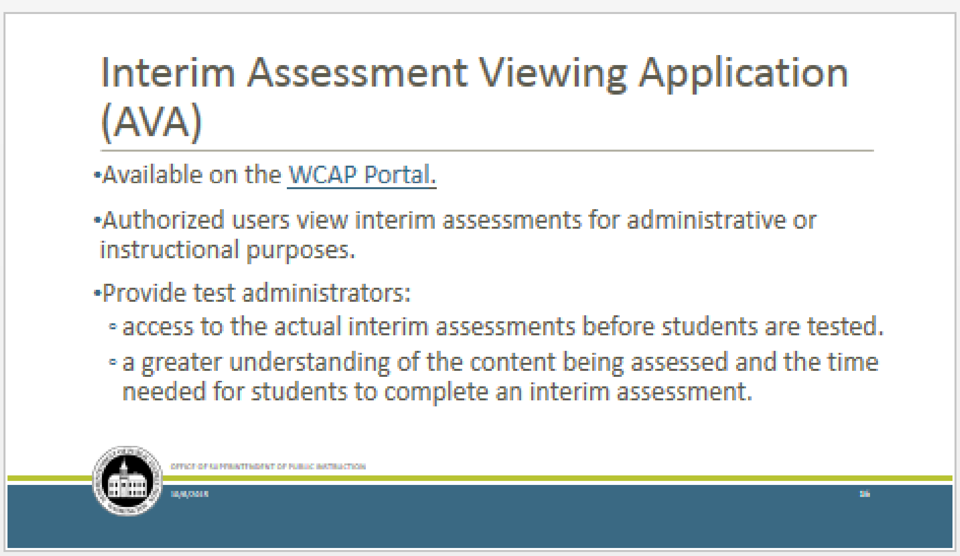
6

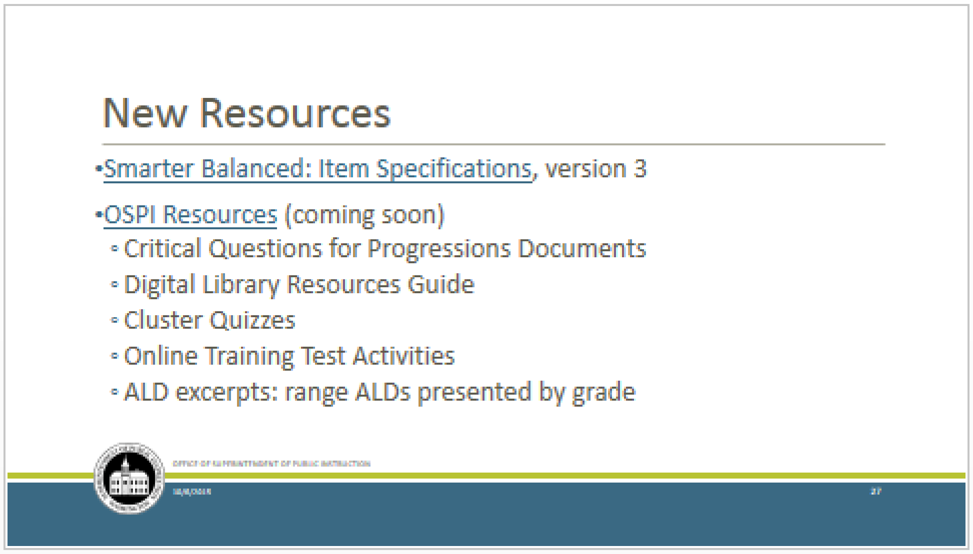
Interim Assessment Blocks (IAB)

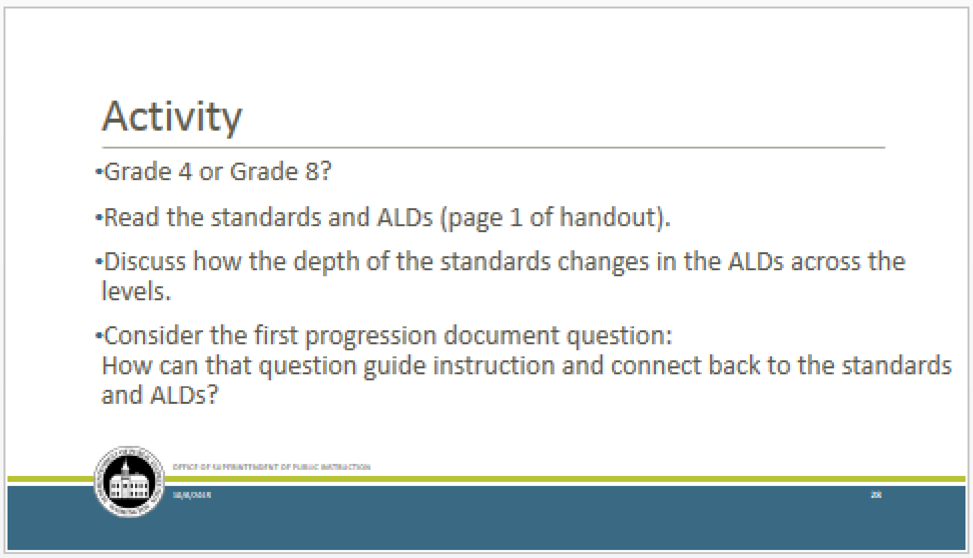
- *Interim Assessment Blocks* handout
- Four blocks per grade
  - 3 "content" blocks
  - 1 Performance Task block
- Block blueprints available in "General Information" folder on the WCAP Portal

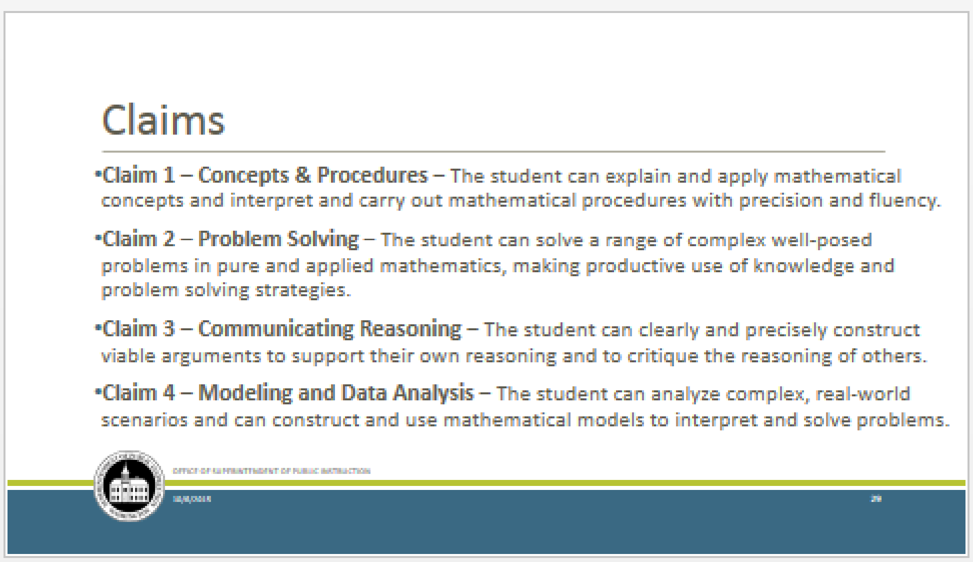

Suggestions for Selecting Interims
•Are there areas of content needs, based on other evidence?
•Are there area of assessment needs, based on data from formative assessment practices?
•Are there areas of need related to the mathematical practices?
•What are the critical areas of focus for the grade level, based on the grade-level summaries in the standards?


What Do We Do With Interim Data?
•Use in combination with other data sources, including other interim assessments.
•Use to evaluate classroom- or school-level instruction.
•Use to compare classroom or school performance pre-instruction and post-instruction.


Interim Assessment Viewing Application (AVA)
•Available on the WCAP Portal.
•Authorized users view interim assessments for administrative or instructional purposes.
•Provide test administrators:
◦ access to the actual interim assessments before students are tested.
◦ a greater understanding of the content being assessed and the time needed for students to complete an interim assessment.


New Resources
•Smarter Balanced: Item Specifications, version 3
•OSPI Resources (coming soon)
◦ Critical Questions for Progressions Documents
◦ Digital Library Resources Guide
◦ Cluster Quizzes
◦ Online Training Test Activities
◦ ALD excerpts: range ALDs presented by grade


Activity
•Grade 4 or Grade 8?
•Read the standards and ALDs (page 1 of handout).
•Discuss how the depth of the standards changes in the ALDs across the levels.
•Consider the first progression document question:
How can that question guide instruction and connect back to the standards and ALDs?


Claims
•Claim 1 – Concepts & Procedures – The student can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.
•Claim 2 – Problem Solving – The student can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.
•Claim 3 – Communicating Reasoning – The student can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others.
•Claim 4 – Modeling and Data Analysis – The student can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems.

Appendix H

Three-Year Transition Plan

Three-Year Transition Plan for Common Core State Standards for Mathematics

While districts can determine their own plan for implementing the Common Core State Standards (CCSS) for Mathematics, the following is a transition plan for those districts who want guidance on how to begin implementing portions of the CCSS. This plan is based on the understanding that the 2008 Washington K-8 Learning Standards will be assessed through 2013-2014. Replacing aligned standards with CCSS domains allows districts to slowly move teachers to the CCSS by emphasizing areas that overlap between the two sets of standards. The cited CCSS domains would be taught in lieu of those 2008 WA standards aligned to these CCSS domains. Any professional development should incorporate the Standards for Mathematical Practice in each domain.

	K-2	3-5	6-8	High School
Year 1 2011-2012	*School districts that can, should consider adopting the CCSS for K-2 in total.* K – Counting and Cardinality (CC); Operations and Algebraic Thinking (OA) 1 – Operations and Algebraic Thinking (OA); Number and Operations in Base Ten (NBT) 2 – Operations and Algebraic Thinking (OA); Number and Operations in Base Ten (NBT) **and remaining 2008 WA Standards**	3 – Number and Operations – Fractions (NF) 4 – Number and Operations – Fractions (NF) 5 – Number and Operations – Fractions (NF) **and remaining 2008 WA Standards**	6 – Ratio and Proportion Relationships (RP) 7 – Ratio and Proportion Relationships (RP) 8 – Expressions and Equations (EE) **and remaining 2008 WA Standards**	Teach all of the 2008 WA Mathematics Standards for each course **and prepare for** Algebra 1- Unit 2: Linear and Exponential Relationships Geometry- Unit 1: Congruence, Proof and Constructions **and** Unit 4: Connecting Algebra and Geometry through Coordinates

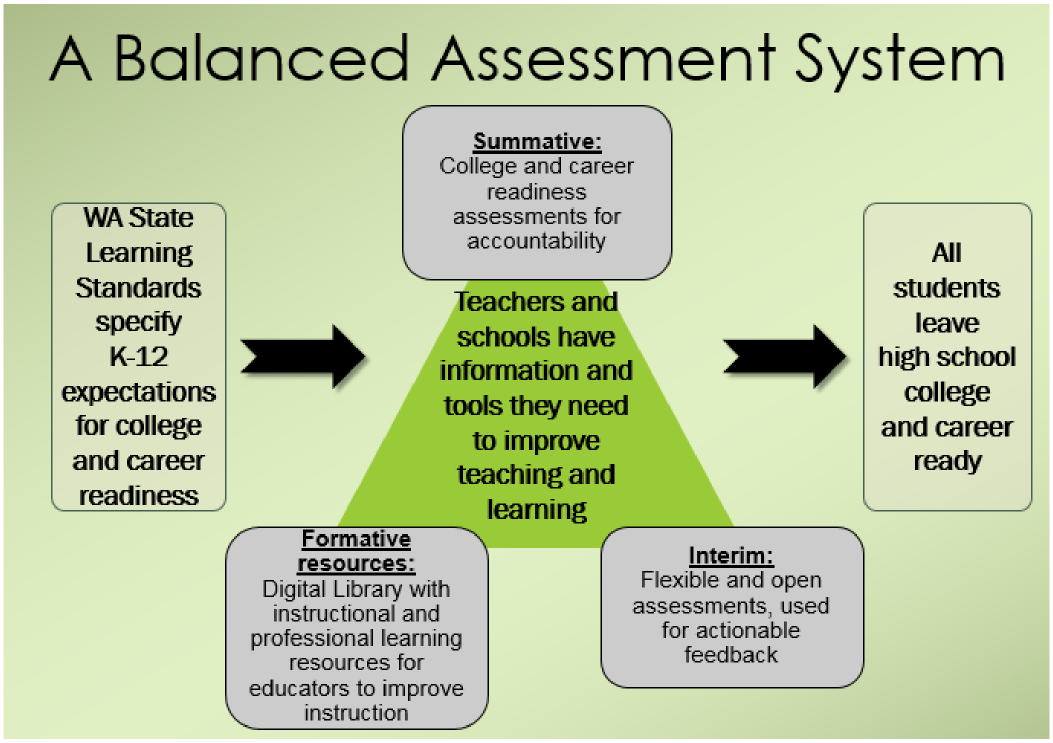
3/15/2012

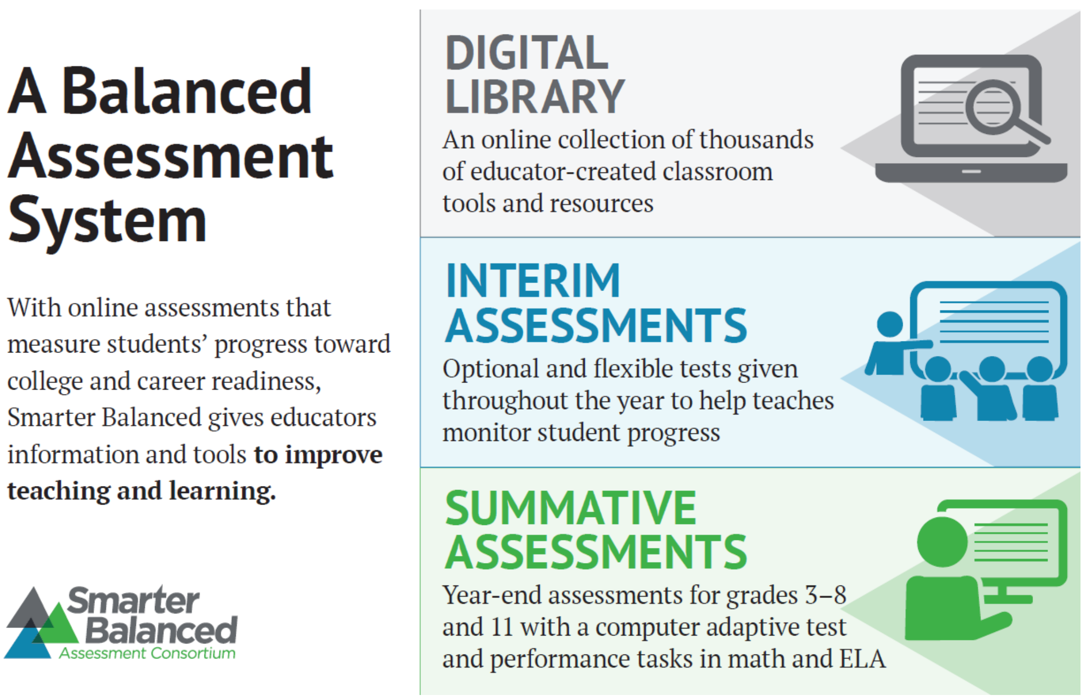
	K-2	3-5	6-8	High School
Year 2 2012-2013	*School districts that can, should consider adopting the CCSS for K-2 in total.* **Year One domains** and: K- Measurement and Data (MD) 1 – Measurement and Data (MD) 2 – Measurement and Data (MD) **and remaining 2008 WA Standards**	**Year One domain** and: 3 – Operations and Algebraic Thinking (OA); Number and Operations in Base Ten (NBT) 4 – Operations and Algebraic Thinking (OA); Number and Operations in Base Ten (NBT) 5 - Operations and Algebraic Thinking (OA); Number and Operations in Base Ten (NBT) **and remaining 2008 WA Standards**	**Year One domain** and: 6- The Number System (NS); Expressions and Equations (EE) 7 - The Number System (NS); Expressions and Equations (EE) 8 – The Number System (NS); Functions (F) **and remaining 2008 WA Standards**	**Year One units** and: Algebra 1- Unit 1: Relationship Between Quantities and Reasoning with Equations and Unit 4: Expressions and Equations Geometry- Unit 2: Similarity, Proof, and Trigonometry and Unit 3:Extending to Three Dimensions **and remaining 2008 WA Standards**

	K-2	3-5	6-8	High School
Year 3 2013-2014	*School districts that can, should consider adopting the CCSS for K-2 in total.* **Year One and Two** domains, and: K – Geometry (G) 1 – Geometry (G) 2 – Geometry (G) **and remaining 2008 WA Standards**	**Year One and Two** domains, and: 3 – Measurement and Data (MD) 4 – Measurement and Data (MD) 5 – Measurement and Data (MD) **and remaining 2008 WA Standards**	**Year One and Two** domains, and: 6 – Geometry (G); Statistics and Probability (SP) 7 – Geometry (G); Statistics and Probability (SP) 8 – Geometry (G); Statistics and Probability (SP) **and remaining 2008 WA Standards**	**Year One and Two** units, and: Algebra 1- Unit 3: Descriptive Statistics **and** Unit 5: Quadratic Functions and Modeling Geometry- Unit 5: Circles With and Without Coordinates **and** Unit 6:Applications of Probability **and remaining 2008 WA Standards**
K-2	**3-5**	**6-8**	**High School**	**K-2**
Year 4 2014-2015	Full implementation of CCSS	Full implementation of CCSS	Full implementation of CCSS	Full implementation of CCSS

Appendix I

Smarter Balanced Assessment System





Appendix J

Claims for the Mathematics Summative Assessment

Claim #1 – Concepts & Procedures "Students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency."
Claim #2 – Problem Solving "Students can solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies."
Claim #3 – Communicating Reasoning "Students can clearly and precisely construct viable arguments to support their own reasoning and to critique the reasoning of others."
Claim #4 – Modeling and Data Analysis "Students can analyze complex, real-world scenarios and can construct and use mathematical models to interpret and solve problems."

Appendix K

Standards for Mathematical Practice

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

CCSS.MATH.PRACTICE.MP1 **Make sense of problems and persevere in solving them.**

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

CCSS.MATH.PRACTICE.MP2 **Reason abstractly and quantitatively.**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

CCSS.MATH.PRACTICE.MP4 Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

CCSS.MATH.PRACTICE.MP5 **Use appropriate tools strategically.**

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

CCSS.MATH.PRACTICE.MP6 **Attend to precision.**

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

CCSS.MATH.PRACTICE.MP7 **Look for and make use of structure.**

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7 × 8 equals the well remembered 7 × 5 + 7 × 3, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2 × 7 and the 9 as 2 + 7. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

CCSS.MATH.PRACTICE.MP8 **Look for and express regularity in repeated reasoning.**

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.