Using Khan Academy Mappers for Math Differentiation

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Abstract

In the 2017-18 school year, Henderson County Schools (HCS) adopted the 1:1 student-technology policy to incorporate a blended learning environment to increase student engagement and achievement. The HCS technology team applied and won the technology grant that supplied the district with Chromebooks. During our convocation, our theme of the year was "providing differentiation through technology." HCS provided numerous professional developments for faculty that included classroom management, Google Apps for Education (GAFE), and SAMR models. These professional developments helped to learn how to integrate technology into the classroom. Therefore, the faculty was excited about the prospects of designing technology-enhanced lessons that provided differentiation within the class. However, the excitement was short-lived. During the parent-teacher conferences, there were various parents upset about the lack of differentiation within the lessons. The outrage that their children weren't academically challenged, especially in math. The math department was called in for a meeting after school to discuss some potential strategies to increase differentiation within the classroom. We were sent on more professional developments.

However, these training lacked innovated techniques to provide math differentiation above the elementary level. Also, most of the methods were already being implemented or just impractical for our class sizes. Therefore, the math department was tasked with finding instructional strategies that provided differentiation for each Rasch Unit (RIT) band of math using technology. There is a lack of professional development and low-cost web-based tools that are tailored to provide differentiation in math for a large, diverse student population. It is our responsibility as math educators to offer rigorous and practical math instruction to all students.

Every year, Kentucky students participate in the NWEA's Measure of Academic Progress (MAP's) testing for reading and mathematics. The MAP testing is usually completed in the Fall, Winter, and Spring to measure the academic growth of our students. Teachers are expected to provide intervention and differentiation for each student to achieve their growth goal. However, the traditional general classroom is comprised of twenty-five to thirty students with varying Rasch Unit (RIT) band scores. Therefore, Khan Academy (a free non-profit educational technology tool) partnered with the NWEA (creators of MAP testing) to design and personalize rigorous instruction for each RIT band in each of the tested categories on the MAP testing.

Khan Academy Mappers is a math classroom-tested instructional strategy for differentiation. This learning technology consists of instructional videos, lessons, and interactive whiteboard for students to practice math skills at their own pace. Each lesson includes four to eight rigorous problems that span from concrete based math drills to real-world application word problems. Students are encouraged to self-learn and use the resources provided to complete each lesson at 100% accuracy. Additionally, Khan Academy offers students remedial lessons to complete to activate prior knowledge if needed. Teachers are categorized as Instructional Coaches on Khan Academy and, therefore, can monitor each student and their progress on completing lessons.

Description:

The roundtable session introduces the technological tool of Khan Academy Mappers and its instructional use to differentiate math in a blended classroom environment. Khan Academy Mappers is a joint endeavor with the Northwest Evaluation Association (NWEA) that created personalize lessons that catered to each Rausch Unit (RIT) band. The discussion will provide instructional strategies and a handout detailing the steps to set-up student scores and data-tracking examples.

Background of standards:
According to the National Council of Teaching Mathematics (NCTM), the three primary principles and standards are the following:

- Equity: "Excellence in mathematics education requires equity-high expectations and strong support for all students" (NCTM, p.2, n.d.)
- Learning: "Students must learn mathematics with understanding, actively building new knowledge from experience and previous knowledge" (NCTM, p.2, n.d.)
- Technology: "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, p.3, n.d.)
- Integrating Khan Academy Mappers ensures the standards are being implemented for all math students using the best instructional strategy to incorporate personalized lessons for each RIT band that is customized to each student's RIT scores.
- The Khan Academy Mappers aligns with the Common Core Standards and mathematical practices for each grade level. Therefore, students are completing rigorous coursework per the Common Core Standards guidelines.

Significance to teachers:
The Professional Growth Plan (PGP) is the Kentucky teacher accountability program that is used for annual evaluation. Some of the primary components on the PGP are the following:
Domain 1—Planning and Preparation: 1D- Demonstrating Knowledge of Resources.
Domain 2— Classroom Environment: 2B- Establishing a Culture of Learning.
Domain 3— Instruction: 3C- Engaging Students in Learning and 3D- Using Assessment in Instruction.
Domain 4 — Professional Responsibilities: 4A- Reflecting on Teaching and 4B-Maintaining Accurate Records.

The clusters stated above are some of the units of measurement that counts as teacher's annual evaluations. The integration of Khan Academy Mappers is a great educational tool that will aid teachers in achieving professional growth while increasing student growth scores on the measures of academic progress (MAPs) testing.

Moreover, Khan Academy Mappers provides math teachers an instructional strategy to differentiate math for different ability levels for a large classroom. Most intervention courses and programs require small group instruction.

However, Khan Academy is a technological tool that aids teachers in differentiating math instruction and provide rigorous coursework for students of multiple ability levels at the same time. Instructional time is precious, and teachers are required and expected to teach the curriculum while simultaneously personalize instruction to increase student learning outcomes. Khan Academy Mappers is a tool that will aid in the teacher's instructional design to achieve professional goals without sacrificing precious instructional time.

Domain 1—planning and preparation: 1d- demonstrating knowledge of resources
The subdomain demonstrating knowledge of resources is an easy component to reach an accomplish status by the end of the year. The subdomain requires that educators know of the available resources that can be integrated into the classrooms to increase student learning outcomes. One of the primary options to fulfill the criteria is to attend professional developments or conferences that will enhance awareness of new resources or new instructional strategies to incorporate resources in the classroom. Another option to fulfill the criteria is the effective planning of the resource to integrate into the classroom, then share the implementation and results with colleagues and parents.

Henderson County provided a technology professional development at the end of every school year. At one of the sessions, the math department chair, Stacey Hyslop, introduced Khan Academy's new beta feature Khan Academy Mappers. The tool was a cooperative endeavor from NWEA and Khan Academy to compile a lesson for each RIT band in each of the math domains for elementary and middle grades. The focus of the presentation is the introduction of a technological tool that would be useful for advanced math students that wanted to challenge themselves and increase the growth scores on the MAPs testing. Also, to provide another valuable resource for the educational tool kit.

After the session, additional research was needed to learn how to implement the resource into weekly instruction effectively and how to use the tool for students of different math abilities. The decision to use Khan Academy Mappers, the next school year as a differentiation tool to increase student growth scores, and communicating with parents about the importance of Khan Academy Mappers tool in the classroom will aid in demonstrating knowledge of the resource.

Domain 2— classroom environment: 2b- establishing a culture of learning

Teachers are held accountable for establishing a culture of learning in the classroom. Some strategies to ensure a positive learning environment is to set high expectations for students, explain the "why," and encourage parent involvement. Setting high expectations is critical for establishing a culture of learning. Students need to know what is expected of them so they can strive to achieve the goal. Also, explaining the "why" it is essential and "why" is it necessary to learn math is critical to increasing student engagement and motivation to complete the math assignments, especially for difficult concepts.

Therefore, when introducing the Khan Academy Mappers, it is essential to instill high expectations of independent thinking, critical thinking, and self-learning for students. Students need to learn how to think for themselves. Independent thinking is such a hard concept to develop. However, when students are taking the standardized test or trying to solve a problem, they need to be equipped with the problem-solving strategies that will help in making the right choice. Students will not always be told how to solve the problem, and therefore, they need critical thinking skills to identify new techniques to solve problems or find unique solutions. Also, students need to learn how they best learn a new concept. As a middle school educator, a part of the job is ensuring students are ready for the next stage in their school career. In high school and college, students will have the expectations to retain the knowledge the best way for them and are expected to transfer or apply the knowledge in everyday situations and on academic assessments.

Moreover, explaining the "why" is just as important. Students need to know why they must learn these skills. So, when introducing Khan Academy Mappers as a new formative assessment tool to complete during class and at home, it is crucial to justify the reasoning. In the Henderson County School district, students are enrolled in specific math courses based on their MAPs scores. If the goal for the student is to participate in the advance or double advance math courses, they will need to reach their growth score and score a distinguish rating on MAP testing. If the students do not want to take an extra math course as intervention, they will need to meet their growth score and grade level benchmark. So, explaining the facts to the students piques their interest in learning more about growth, benchmark, and the novice, apprentice, proficient, and distinguished scores. Also, explaining what growth means and how it works is beneficial for students to visualize their goal at the end of the school year.

As previously mentioned, setting high expectations for students is necessary for establishing a culture of learning. Therefore, giving students an arbitrary point to achieve by the Spring of the school year aids in a concrete goal for students to complete. For example, in my classroom, I tell all students that growth is six points above their Spring score. I will also tell students that the six points are divided by the three MAP tests that they take throughout the school year, so two points for Fall, two points for Winter, and two points for Spring. So, if a student previously scored a 225 in the Spring of last school year, by the Spring of the current school year, students must reach a 231. Alternatively, for the students that score higher such as a 250, their goal by the end of the Spring of the current school year is 256. Most students will gasp and start to think it is impossible. Yet, it is not. That's when I introduce Khan Academy Mappers. Letting the students know that the Khan Academy Mappers is a site that will provide personalized instruction within their focus areas will help them reach their growth goal since the NWEA that wrote the MAP testing is the same organization that helps create the Khan Academy Mappers. Try giving the scenario of basketball players need to attend and give 100% at practice, so they can play the game to win. It is the same; students will need to participate and give 100% to completing the lessons to achieve the goal during the MAP testing.

Furthermore, the Khan Academy Mappers will produce a productive struggle for the students. The lessons are personalized within their RIT bands; some of the lessons may prove to be challenging or new to the students, which is why it is crucial to encourage parent involvement. Communicating with parents about the importance of Khan Academy Mappers and providing additional resources that will help students to learn new math concepts outside of the classroom is critical for success. Students need to know that the parents and teachers are on the same page for their education to help establish the culture of learning.

Domain 3— instruction: 3c- engaging students in learning and

Integrating Khan Academy Mappers in class is an essential component for student engagement. Scheduling a block of instructional time for students to only work on Khan Academy Mappers will help in instilling the importance of Khan Academy Mappers and time for the students to work on new skills that may need some guidance from the teacher. In my classroom, every Friday during their second math block is called Khan Academy Friday. Students are in a routine to enter the class, log in to their Khan Academy accounts and start working on that nine weeks strand (1st nine weeks Operations and Algebraic Thinking, 2nd nine weeks Real and Complex Numbers, 3rd nine weeks Geometry, and 4th nine weeks are Statistics and Probability). However, the setup for students can vary with each teacher; I use this set-up as it aligns with my curriculum map, and students are all working on the same strand at the same time.

Domain 3— instruction: 3d- using assessment in instruction

Furthermore, I use Khan Academy as a formative assessment for student grades. Some students need that extra motivation for completing lessons, especially for those students that have over fifty lessons to complete within a strand due to their RIT band. So, assigning students a set of lessons to complete within the nine weeks is beneficial to prevent student shut-down. For instance, in my classroom, students are required to complete at least ten lessons each nine weeks. Favoring student choice as another engagement factor is beneficial, so I allow students to choose which ten they want to complete within that nine-week strand. To encourage students to complete additional lessons, I offer classroom rewards such as candy, extra credit, or tech time for students that complete five extra lessons, ten extra lessons, or fifteen extra lessons, respectively. The reward factor is beneficial for students that need extrinsic motivation to complete the Khan Academy Mappers.

Moreover, Khan Academy Mappers permits students and teachers to update MAP scores to gain new lessons as the students continue to improve on the MAP test. The updating feature on the Khan Academy site is beneficial to continually personalize lessons for students as they continue to grow and increase their scores on MAP testing.

Domain 4 — professional responsibilities: 4a- reflecting on teaching

Reflecting on teaching is an essential skill for every teacher. Learning and understanding what worked well in the classroom and adjusting throughout the year to lessons that need refinement are imperative. When integrating Khan Academy Mappers, it is vital to observe student behaviors, attitudes, and engagement levels to identifying each student's zone of proximal development (ZPD). The role of the teacher is to facilitate the Khan Academy Mappers, where the lessons generate productive struggle. However, if lessons are too complicated, students will become frustrated or anxious and not succeed in completing the lessons. Also, a negative connotation will be attached to Khan Academy Mappers.

Exceeding the ZPD is not the objective of Khan Academy Mappers. So, it is essential to reflect on teaching, to adjust the number of lessons, assign particular lessons that the students will need for the current grade level, adjust percentages achieved for specific lessons, or introduce or reteach strategies to help students understand the concept. For instance, I had a student that scored above grade level on the MAP test. Once the raw score for each strand was entered in Khan Academy Mappers, it generated lessons that were high school level. After careful observation, I conferenced with the student to identify some lessons that were grade level within the strand and some challenging lessons that I adjusted the percentage achieved. The strategy of reflecting on teaching was essential to identify what lessons are necessary for optimal growth in the eighth grade and which lessons will challenge the student's math abilities.

Domain 4 — professional responsibilities: 4b-maintaining accurate records.

Khan Academy Mappers does not have a teacher monitor screen unlike the regular classroom version of Khan Academy. Therefore, it is vital to maintain accurate records of student's completed lessons and students' scores on the MAP test. Having a history of students MAP scores from spring of the last academic school year, fall, winter, and spring of the current school year is critical to use as students prepare for the MAP test to know what their goal to reach, to let the teacher know if the student is succeeding, and to provide as documentation for PGP. It is easy to create a data sheet for each class using Google Docs. On Google Docs, I created a table with the title listing the class period underneath the title in the right column is a list of the student's name, the next column has the students last year's spring MAP score. The next column is the fall score, next column is the winter goal, the next column is the winter score, the next column is the spring goal score, the next column is the spring score, and the last column is the student's novice, apprentice, proficient, or distinguish level based on their spring MAP score. Figure 1 is a snapshot of a template I created to use for my classroom and that I shared with colleagues to use for their class. It is color coated to help make the document easy to read. As a result, I let the students know if they completed their growth goal through a celebration. Students that meet their goal will have the names on a poster, have their choice of soft drink, and a bag of chips. Again, reflecting on teaching at the middle school level, some students need extrinsic motivation to fulfill their potential and engage in learning.

MAP's Growth Test 19-20

Student	Spring '19	Fall	Winter Goal	Winter	Spring Goal	Spring	Rating N, A, P, D

Figure 1. MAP's Growth Test Snapshot

Furthermore, our math department chair Stacey Hyslop created a document for students to track their data and goals. The data-tracking sheet is a great resource to use for students to have a visual and a reminder of their goals that they need to achieve. The tracking sheet also encourages students to take ownership of their learning. I usually complete the top half of the sheet for the students. The bottom half displays the Khan Academy Mappers website and the strands for the fall, winter, and spring. Figure 2 displays a snapshot of the student data-tracking tool for the 2019-2020 school year with a few modifications that I made to suit my classroom and students.

8th grade Math MAP Scores 2019-2020

Math Goal	Fall	Winter	Spring
Distinguished	249-350	251-350	253-350
Proficient	230-248	233-250	235-252
Apprentice	210-229	213-232	215-234
Novice	100-209	100-212	100-214

Name: _____

Spring-2019_____

Goal Fall(2019)_____

Fall-2019_____

Goal Winter-2020_____

Winter-2020_____

Goal Spring-2020:_____

Spring-2020_____

KHAN ACADEMY MAPPERS: khanacademy.org/mappers

Fall Strands: Operation and Algebraic Thinking_____

Real and Complex Numbers_____

Geometry_____

Statistics and Probability_____

Figure 2. Snapshot of Student Data-Tracking Sheet

<p align="center">**Khan Academy Mappers in classroom**</p>

Implementation in the classroom

Henderson County North Middle School, typical schedule is two blocks of math, two blocks of English and language arts (ELA), Cadets in Action (CIA), and two blocks of electives. Therefore, I will have three groups of students twice a day. In a typical math class, the morning session consists of daily instruction, and the afternoon session is review and practice.

After the first two weeks of school, I will gather the NWEA MAP data for each of my students and separate the data by class. Once each class is divided, I would go through the students' score sheets and write their Spring Goal. During each afternoon session, I will introduce Khan Academy Mappers and explain the "why" for completing the Mappers. Then, I would model the instructions for the students to complete. On the smartboard, I will display the Khan Academy Mappers website, and show how students will log in and put in their scores. At this step, students may start to feel overwhelmed based on how many lessons they will need to complete lessons usually range from one to one hundred and fifty. Therefore, to reduce the feeling of panic, I will assign a set amount of lessons for the students to complete each term. Usually, I will assign ten lessons (each lesson will be worth 10 points) for the entire nine weeks, and the students will have a designated day to work on during class time. Those designated days are called "Khan Academy Fridays". In addition, I assign the students the same strand to work on during the nine weeks. Khan Academy Mappers recommends for students to work on the strand that scored the lowest on first, but I like my classes to be uniformed and for the Khan Academy Mapper lessons to align with the units that I am teaching.

The Khan Academy Mappers is a formative assessment grade. Each lesson is worth ten points for a total of a hundred points. Students will have the entire nine-weeks to complete the assignments. Students have the option to stay after school one day of the week to work on the Khan Academy Mapper lessons. Students must score at least a seventy percent to obtain full points. Since the Khan Academy Mappers is still in Beta testing, the teacher can not monitor student progress on the Khan Academy Coach screen. Therefore, students must take screenshots of completed lessons, paste screenshots on a Google document, and upload the Google document to Google Classroom for submission. Students are rewarded for completing additional lessons. For every five other lessons students complete they will receive PBIS points and candy, for every ten other points students will earn three extra credit points on lowest formative assessment, and if the student completes fifteen or more additional lessons, they will receive ten minutes of tech time during the afternoon session of math class.

As illustrated in table one, units and the timeframe for every nine weeks are listed with the corresponding strand. Some strands will occasionally overlap with some of the other units, but the majority are aligned. One of the major units in eighth-grade math is the slope. The slope is practice in operations and algebraic thinking strand, so it is a great conversation starter and introduction to the slope. Students that practice slope during the operations and algebraic strand typically develop an understanding of how to identify and calculate slope on a concrete level. Thus, the group of students that complete slope lessons, have fewer difficulties during the slope unit and most likely become peer tutors throughout the unit. However, it is necessary to practice geometry during the third nine weeks since the KPREP is completed during the fourth nine weeks, and geometry is one of the primary math strands tested.

<p align="center">*Table 1.*</p>

Eighth Grade Math Curriculum Map		
Nine Weeks	Thematic Units	Khan Academy Mappers Strand
First Nine Weeks August through October (before fall break)	Unit 1: Exponents Unit 2: Rational and Irrational Numbers Unit 3: Solving Equations (first half)	Operations and Algebraic Thinking Students complete ten lessons of their choosing from this strand.
Second Nine Weeks October (after fall break) through December	Unit 3: Solving Equations (second half) Unit 4: Volume Unit 5: Slope	Real and Complex Numbers Students complete ten lessons of their choosing from this strand.

Third Nine Weeks January through March	Unit 6: Pythagorean Theorem Unit 7: Systems of Equations Unit 8: Functions Unit 9: Scatterplots	Geometry Students complete ten lessons of their choosing from this strand.
Fourth Nine Weeks April through May	Unit 10: Transformations Unit 11: Angles	Statistics and Probability Students complete ten lessons of their choosing from this strand.

MAP correlation to KPREP

A significant factor for teachers and students is to understand the MAP score correlation with the KPREP. The NWEA website offers multiple tables to display various types of correlations. The correlation that I print out for each of my students and review are the KPREP scores and the spring MAP scores. Therefore, starting with the end in mind, the students will identify their goal for KPREP and the score they will need to achieve on the spring MAP test to ensure that they are on the right track. Figure 3 shows the correlation tables of the KPREP scores and percentiles with the corresponding spring MAP testing scores.

	K-PREP			
Grade	Level 1 *Novice*	Level 2 *Apprentice*	Level 3 *Proficient*	Level 4 *Distinguished*
3	100-191	192-209	**210**-233	234-300
4	100-193	194-209	**210**-228	229-300
5	100-191	192-209	**210**-228	229-300
6	100-190	191-209	**210**-230	231-300
7	100-191	192-209	**210**-230	231-300
8	100-191	192-209	**210**-231	232-300

	MAP							
Grade	Level 1 *Novice*		Level 2 *Apprentice*		Level 3 *Proficient*		Level 4 *Distinguished*	
	RIT	%ile	RIT	%ile	RIT	%ile	RIT	%ile
3	100-191	1-19	192-204	20-53	**205**-217	54-84	218-350	85-99
4	100-198	1-15	199-212	16-47	**213**-225	48-78	226-350	79-99
5	100-202	1-12	203-220	13-47	**221**-235	48-80	236-350	81-99
6	100-205	1-11	206-223	12-45	**224**-238	46-78	239-350	79-99
7	100-212	1-18	213-230	19-54	**231**-245	55-83	246-350	84-99
8	100-214	1-19	215-234	20-57	**235**-252	58-87	253-350	88-99

Notes. 1. %ile=percentile.
2. Bolded numbers indicate the cut scores considered to be at least "proficient" for accountability purposes.

Figure 1. Correlation of KPREP and spring MAP scores (NWEA, 2017)

Another exciting factor that teachers can use as a method of reflection and aid in completing the mid-reflection is the correlation tables of the KPREP scores and the fall and winter MAP scores. Our school district, MAP test in the fall, winter, and spring. Therefore, the added piece of data is beneficial to identify students are falling behind, on-track, or exceeding the expected goals. Figure 4 is a great conference and communication tool to use with students one-on-one to encourage students to keep working hard or to identify the potential areas and strategies that students may need additional guidance.

K-PREP				
Grade	Level 1 *Novice*	Level 2 *Apprentice*	Level 3 *Proficient*	Level 4 *Distinguished*
3	100-197	198-209	**210**-225	226-300
4	100-196	197-209	**210**-226	227-300
5	100-197	198-209	**210**-225	226-300
6	100-198	199-209	**210**-226	227-300
7	100-198	199-209	**210**-225	226-300
8	100-198	199-209	**210**-224	225-300

MAP FALL								
Grade	Level 1 *Novice*		Level 2 *Apprentice*		Level 3 *Proficient*		Level 4 *Distinguished*	
	RIT	%ile	RIT	%ile	RIT	%ile	RIT	%ile
3	100-178	1-26	179-190	27-55	**191**-202	56-81	203-350	82-99
4	100-187	1-24	188-199	25-53	**200**-213	54-83	214-350	84-99
5	100-193	1-21	194-206	22-52	**207**-221	53-85	222-350	86-99
6	100-200	1-24	201-210	25-48	**211**-225	49-83	226-350	84-99
7	100-203	1-23	204-214	24-50	**215**-228	51-82	229-350	83-99
8	100-208	1-28	209-220	29-58	**221**-234	59-86	235-350	87-99

MAP WINTER								
Grade	Level 1 *Novice*		Level 2 *Apprentice*		Level 3 *Proficient*		Level 4 *Distinguished*	
	RIT	%ile	RIT	%ile	RIT	%ile	RIT	%ile
3	100-186	1-27	187-197	28-54	**198**-208	55-80	209-350	81-99
4	100-193	1-24	194-205	25-55	**206**-218	56-84	219-350	85-99
5	100-198	1-21	199-210	22-51	**211**-224	52-84	225-350	85-99
6	100-204	1-25	205-213	26-48	**214**-227	49-81	228-350	82-99
7	100-206	1-24	207-217	25-51	**218**-229	52-79	230-350	80-99
8	100-211	1-31	212-221	32-56	**222**-235	57-85	236-350	86-99

Notes. 1. %ile=percentile.
2. Bolded numbers indicate the cut scores considered to be at least "proficient" for accountability purposes.

Figure 2. Correlation of KPREP and fall and winter MAP scores (NWEA, 2017)

Results

Khan Academy Mappers provided differentiation to all students on various RIT levels. Parents were satisfied with the level of rigor that the students were practicing math at home and in the classroom. The students were motivated to gain new skills that increased their MAP scores and understanding of math concepts.

Also, Khan Academy provided the flexibility of updating the student's scores after each MAP test to allow students to continue to improve their MAP scores. At the end of the year, most of the students surpassed their goal and growth score on the spring MAP testing. The effective use of Khan Academy Mappers differentiation narrowed

the achievement gap within the school district.

During the fall of the 2018-19 school year, KPREP scores were released, and the math department was praised in the increase test scores of the students. The HCS middle school math scores were 8th in the state with a score of 66.3, which surpasses the state average of 47 by 19.3 points.

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