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Culturally Sustaining Practices for Middle Level Mathematics Teachers

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Abstract: This chapter provides middle school mathematics teachers with strategies to specifically address culturally responsive teaching goals. Authors provide background on culturally sustaining practices and use Ellerbrock and Vomvoridi-Ivanovic's (2019) three goals for Responsive Middle Level Mathematics Teaching (RMLMT) as a foundation to suggest three specific tools middle level practitioners can use to enhance their students' experiences. The first goal, advancing young adolescent learners' mathematical thinking, includes getting to know individuals' mathematical selves. Goal two addresses promoting equity in young adolescent learner's mathematical classroom learning experiences. Goal three, attending to young adolescents' characteristics, needs, and interests, includes an examination of ways to use young adolescent characteristics in middle school math classrooms. The three tools we are recommending include: reflection, literacy integration, and utilization of place-based, problem-based learning. Each of these tools reflect practices that sustain an environment operationalizing the goals of RMLMT.

Keywords: culturally relevant; culturally responsive; culturally sustaining practices; middle school math tools; mathematics teachers

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1. Introduction

The student populations in classrooms across the United States are becoming more diverse, while our teachers are becoming less diverse [1]. The current demographics of teachers between 2009 and 2020 across the United States estimates that over 70% of the teachers in the workforce are White females [1] and the demographics of Hispanic students have increased from 22% to 28%, while Black and White students have declined from 17% to 15% and 54% to 46%, respectively [2]. The opportunity gap that exists in our country is egregious.

As Mathematics Teacher Educators (MTE), we seek ways to promote equity and support diversity among our students. Culturally sustaining practices are intentional opportunities teachers engage in and create to support all students. Thought leaders may use the term culturally responsive pedagogy and culturally sustaining practices interchangeably. As in much of the current, relevant literature, we use culturally sustaining with the notion that sustaining indicates a long-term commitment and impact. We offer a conceptually grounded model of ways in which culturally sustaining practices may be introduced and emphasized in mathematics education.

Culturally sustaining practices in middle level teacher education methods classes begin with an exploration of work conducted by education thought leaders [3]. Culturally sustaining pedagogy include "linguistic, literate, and cultural pluralism as part of schooling for positive social transformation" [3] p. 1. The pedagogy is grounded in multiculturalism

and asset-based practices that validate and affirm linguistics, literacy, as well as cultural practices of historically marginalized communities [3]. Banks [4], multiculturalism author and advocate, states that multicultural education "is designed to restructure educational institutions so that all students, including middle class white males, will acquire the knowledge, skills, and attitudes needed to function effectively in a culturally and ethnically diverse nation and world" [4] p. 23.

Aguirre and Zavala [5] designed a tool for mathematics teachers. They use the term Culturally Responsive Mathematics Teachers (CRMT). The authors state: First, "culturally responsive mathematics teachers must develop a socio-cultural–political consciousness. This means teachers must understand teaching and learning as part of a broader socio-political context and see their job as preparing students to engage in these contexts . . . . Second, teachers must understand and embrace social constructivist and socio-cultural theories of learning . . . so their students [can] construct knowledge through social interactions that are mediated by language and culture . . . And third, teachers must focus on getting to know and leveraging the mathematical resources of students, their families, and their communities . . . [believing that] knowledge, experiences, and skills [are] intellectual resources, rather than deficits, for mathematics teaching and learning" [3], pp. 167–168.

Expanding on the CRMT work of Aguirre and Zavala [5], Ellerbrock and Vomvoridi-Ivanovic [6] examined this tool to address developmentally responsive teaching specifically associated with middle level mathematics teaching. They added a focus on young adolescent characteristics described in literature to expand Aguirre and Zavala's framework to focus specifically on young adolescent characteristics and needs [7–9]. Ellerbrock and Vomvoridi-Ivanovic [6] address three specific goals for Responsive Middle Level Mathematics Teaching (RMLMT). The three goals they identified are: To advance young adolescent learners' mathematical thinking; promote equity in young adolescent learner's mathematical classroom learning experiences; and attend to young adolescents' characteristics, needs, and interests. We selected these works as the foundation on which to base our examples providing mathematics teachers with specific strategies that address the dimensions outlined by Ellerbrock and Vomvoridi-Ivanovic [6].

This chapter begins with an overview of culturally sustaining practices middle level education and middle school mathematics leaders are sharing about meeting the needs of young adolescents. We provide three examples we use that address culturally sustaining practices. We then operationalize these three examples for educators to support the culturally sustaining for Responsive Middle Level Mathematics Teaching (RMLMT) goals presented by Ellerbrock and Vomvoridi-Ivanovie's [6].

2. Materials and Methods

Middle level mathematics methods professors worked collaboratively to examine literature on culturally relevant practices in the mathematics classroom using narrative inquiry to interpret culturally sustaining practices in the mathematics classroom. This empirical study used narrative inquiry; a form of qualitative research described by Creswell [10]. Narrative inquiry uses personal accounts and an exploration of common themes. Six middle school mathematical methods faculty members researched and discussed insights into their use of culturally sustaining practices. Miller [11] addressed the use of narrative inquiry to gain insights into faculty members' culturally responsive practices. Faculty co-created knowledge of their practices using "first-hand experiences" [12]. The middle school math methods faculty replicated this study by examining literature on culturally responsive and culturally sustaining practices to consider ways of presenting mathematics to middle school students.

Over the course of six weeks, faculty met weekly to discuss current research and to examine their own practices. We examined the work of Aguirre and Zavala's [5] and the work of Ellerbrock and Vomvoridi-Ivanovic [6] to focus on the framework and goals outlined in these works. Initial discussions centered around the most recent work of Paris and Alim [3] who describe the transition from culturally relevant practices to culturally

sustaining practices. We examined and shared their own reflections of their knowledge of and journeys towards becoming culturally responsive to middle school students and what that looks like in the current classrooms of 2022. We examined common practices that relate first to how they interrogate our own Funds of Knowledge [12], equity Literacy [13]) and text lineages they use [14]. Much discussion centered on integrating mathematics and literature. Finally, the work of Ladson-Billings [15], Gay [16], and Hammond [17] were used citing how tasks were associated with cultural and community assets of students.

Using current knowledge of culturally sustaining practices, we selected three tools for middle school math teachers to consider. We reference tools as one of the following: specific structures that create a classroom that supports culture and community, scaffolds and resources that enhance students' thinking, and specific pedagogy that allows teachers to set up an environment of inquiry that supports young adolescent characteristics. Collaboratively, we suggest these tools for math teachers to integrate into their pedagogical practices to create classrooms that are culturally responsive to young adolescents and culturally sustaining as relevant to today's classrooms.

2.1. Review of Literature

2.1.1. Multiculturalism and Culturally Sustaining Practices

In the past two decades, research is moving from multiculturalism towards culturally sustaining practices in middle schools and in math classrooms. Middle school math teachers are seeking ways to provide experiences that focus on equity, culture, and communities [3,18–20]. The Association for Middle Level Education, the National Council of Teachers of Mathematics, as well as the Common Core Standards recognize the value of using examples that reflect culturally sustaining practices.

Alfie Kohn [21] states that our work, as educators, is to help our students locate themselves in "widening circles of care that extend beyond self, beyond country, to all humanity" p. 1. Paris [20], coined the phrase, culturally sustaining pedagogies to describe a more encompassing view; that delivery of instruction should move "toward an education that honors and extends the languages, literacies, and practices of our students and their communities, towards social and cultural justice" p. 96. Culturally responsive practices have been shown to motivate and inspire marginalized students [22–25].

Paris and Alim [3] define culturally sustaining pedagogy as efforts that sustain "linguistic, literate, and cultural pluralism as part of schooling for positive social transformation" p. 1. Their work is grounded in asset-based practices that validate and affirm linguistics, literacy, as well as cultural practices of historically marginalized communities in educational spaces and call for transformative practices that teach educators how to disrupt power structures that have moved historically marginalized cultures from the center. Paris and Alim honor the work of asset-based, culturally relevant and responsive researchers of the past, but they are intentional about including linguistics, literacy, and cultural practices as not just evident in a classroom but include maintenance and social critique [3] p. 5. Gorski [13] provides a framework for considering equity literacy as a tool all teachers should consider. Specifically, Simpson and Cremin [25] examine the value of integrating children's literature as a tool for developing students' equity in classroom learning environments that address asset-based equity literacy.

Nieto [26] and Gay [27] assert that a culturally relevant view focuses on students' backgrounds much like Moll and Gonzalez [28] identify students' Funds of Knowledge. Each of these studies recognize cultural and community assets are critical for helping students gain confidence in their own abilities. Additionally, when teachers focus on their students' needs and intentionally build relationships in their classrooms, students have a better chance of succeeding ([15,23]).

2.1.2. Culturally Relevant Practices in the Mathematics Classroom

Aguirre and Zavala [5] designed a framework for mathematics teachers. They use the term Culturally Responsive Mathematics Teaching (CRMT). The authors summarize that

"culturally responsive mathematics teachers must use the following: mathematical thinking, academic language and language scaffolding strategies, focus on funds of knowledge, culture, and community, and "use of mathematics to understand, critique, and change an important equity or social justice issue in their lives" p. 169. They suggest teachers must focus on getting to know and leveraging the mathematical resources students, their families, and their communities bring to the classroom . . . [believing that] knowledge, experiences, and skills [are] intellectual resources, rather than deficits, for mathematics teaching and learning" [5] pp. 167–168. Expanding on the CRMT work of Aguirre and Zapala [5], Ellerbrock and Vomvoridi-Ivanovic [6] examined this tool to address developmentally responsive teaching specifically associated with middle level mathematics teaching. In their examination they added the critical piece that young adolescent characteristics must also be part of culturally responsive classrooms [6].

Aguirre and Zavala [5] and Ellerbrock and Vomvoridi-Ivanovic [6], provide us with specific dimensions that meet specific goals for middle school mathematics. The following (Table 1) is what we used to support this research.

Table 1. Goals and Dimensions for Middle School Mathematics.

Goal 1: Advance young adolescent learner's mathematical thinking dimensions	
1.	Cognitive Demands
2.	Depth of knowledge and student understanding
3.	Mathematical discourse
Goal 2: Promote equity in young adolescent learners' mathematical experiences dimensions	
4.	Power and participation
5.	Academic language support for English Learners
6.	Cultural/community-based funds of knowledge
Goal 3: Attend to young adolescent learners' characteristics, needs, and interests dimensions	
7.	Physical characteristics
8.	Cognitive-intellectual characteristics
9.	Psychological characteristics
10.	Social-emotional characteristics
11.	Moral characteristics

3. Results

3.1. The Question

What specific tools address the goals of culturally responsive classrooms and how are these viewed as culturally sustaining practices?

3.2. Findings

From our examination of culturally relevant and culturally sustaining practices, we offer three tools to support teachers' use of culturally sustaining practices. We are using the term culturally sustaining to represent how classroom teachers intentionally weave culture and community throughout the planning, implementation, and assessment process.

3.3. Tools to Guide Culturally Sustaining Practices in Middle Grades Education

3.3.1. Reflection

Reflection as a structure to develop Teacher Identity. Reflection, helps teachers address, redress, and assess their own teacher identity as it relates to equity [13]. Russell [29] shares several principles of reflection for teachers including: begin with teaching and trust, engage

in listening to whoever is teaching, share what each person learned in the experience, think about their own thinking—metacognition. Reflection should be based on experiences and should permeate everything that occurs in teacher education. One way to explore and analyze the identities and strengths of middle school students is using writing and reflections, discourse, and other forms of communication in mathematics [30]. Teachers can start by focusing on their own mathematical identities, their problem-solving tactics, and their explanations of mathematical phenomena. When teachers look back at their own experiences, they begin to interrogate how they perceived math, the struggles they had, and/or the joys of learning mathematics.

Mathematical Autobiography. The purpose of writing a mathematics autobiography is to unpack one's experiences with mathematics both in and outside of the school setting. This is a particularly important exercise as we frequently bring preconceived ideas and beliefs to our mathematics learning and teaching. These ideas are a composite of our life experiences, our cultural background, and our educational experiences. Some examples of how these experiences may impact one's general feelings towards mathematics could include the student who has parents who did not like mathematics and therefore any mathematics homework brought home is met with stress from the adults. This stress then influences the student's attitude towards engaging with math problems. Or there is the student who had an incredibly passionate 8th grade math teacher who inspired them daily to see mathematical beauty in everyday experiences. There is of course a wide range of potential experiences across this spectrum, and it is important for teachers to know how and why they hold their current beliefs to then be conscientious about how they will influence adolescents in their classrooms. To accomplish this reflection exercise, we concur that a mathematical autobiography should include two important components: reflection of experiences with learning and teaching mathematics, and how those experiences have influenced the students' ideas about how mathematics should be taught in school.

While this list is not comprehensive, it is a starting point to reflect on the following:

- Self-perceptions about your mathematical abilities and understandings;
- Feelings and attitudes toward mathematics;
- Characterize your learning needs;
- Beliefs about what it means to teach and learn mathematics;
- Important events in your mathematical life (in and out of school);
- Describe your best and/or worst mathematics teachers and how they influenced you mathematically;
- Where you are now in regard to both mathematics learning and mathematics teaching;
- How your background and life experiences influence your teaching and learning.

Digging back into our experiences as learners of mathematics can be quite powerful. Having the opportunity to reflect on educational experience at a detailed level and identifying moments in that journey that either caused a spark or potentially influenced a negative mindset towards mathematics help us know our teacher identity.

Bonner [31] shares research "that real and sustaining relationships and trust cannot be built in the mathematics classroom without first focusing on knowledge (about students, mathematics, culturally connected mathematics, and content) or communication (communicating in culturally connected ways, making mathematics accessible to students, communicating care to students, and allowing students to communicate in comfortable ways)" [31] p. 388. By inviting students to reflect on their own growth, this practice can begin early and develop throughout a teacher's journey and potentially help novice teachers identify their future students' Funds of Knowledge, and build the capacities for culturally sustaining mathematics teaching that begins with building relationships and communication.

To help spark this reflection and provide an avenue for describing one's experiences with mathematics, the following prompt could be used to begin the autobiography, "Math is like . . . " Begin with three options to which teachers can relate and ask them to select one that best describes their experiences—Math is like (1) an automobile, (2) a fast-food

restaurant, or (3) a drink. The simile expands into a more in-depth reflection of their autobiographies as teachers provide explanations and examples. Then, each can begin to construct their own analogies revealing more about their experiences and perspectives. For example, "Math is like a puzzle with many individual parts that once together can form a meaningful picture." "For me, math has been like a roller coaster as some topics I can coast through while others cause me to struggle in the climb."

Journaling. A tool that compliments the mathematical autobiography is journaling. Journaling for both teachers and students allows for a more intentional view into teacher identity as well as students' mathematical conceptual understanding, pedagogical considerations, and emotional experiences. Journaling allows for deeper thinking to happen during class or outside of the school or classroom environment. In other words, it allows for the opportunity to engage in individual discourse. The topics students reflect on can and should relate to skills related to communicating students own power and equity. It can help them consider their own ideas and develop ways to become self-aware thus building more confidence. Using journaling as a springboard for discourse makes conversations and concerns a safe place to share.

For math teachers, journaling can provide a gateway to becoming culturally self-aware and responsive in our classrooms [32]. Creating a culturally sustaining mathematics classroom must include relationship building with communication [16,31]. Getting to know students allows teachers to examine the knowledge base of their students, and enhances relationships. The mathematical autobiography and journaling allow teachers to gather knowledge of their students and can be used to begin mathematical conversations based on background knowledge, ideas and insights as well as allowing students to reflect on their own mathematical journey.

3.3.2. Literacy Integration

In the mathematics classroom, we should consider the cultural and community resources that reflect students. Finding ways to celebrate diversity in mathematics classrooms can be challenging for some. Decisions teachers make can enhance or stifle this. Teachers can examine curriculum resources through an equity or critical lens for whose voice is being shared. Integrating literature in mathematics offers windows, mirrors, and sliding glass doors for students [33]. Students can experience similarities (mirrors) to reflections of their own lives and differences (windows) to learn about others through storylines, characters, settings, or situations.

During planning, teachers can consider the connection between equity and literacy [34]. Delpit [35] defines equity as power and culture in the classroom. Gorski defines equity as "a commitment to deepening individual and institutional understandings of how equity and inequity operate in organizations and societies, and the individual and institutional knowledge, skills, and will to vigilantly identify inequities, eliminate inequities, and actively cultivating equity" [13] p. 1. Standards and resources for middle grade teachers exist that address identity, diversity, justice, and action. Learning for Justice, formerly Teaching Tolerance, provides a document titled Critical practices for anti-biased education that addresses critical engagement. Critical engagement is defined as "requiring questioning, forming and challenging opinions, and feeling outrage or inspiration" [36] p. 10.

In order to engage and empower students, teachers need tools for scaffolding that invite multiple cultures, current events, and questions to ponder into their mathematical classrooms. Specifically, examining how to use social issues in problem solving tasks is a tool for addressing equity. Very often when presenting mathematical concepts, teachers need to find and manipulate materials, ponder and ask real-world and relevant questions, speculate mathematical connections related to personal and cultural events, and share their modeling of problems and solutions with their students. While there are many resources available through the National Council of Teachers of Mathematics (NCTM), state agencies, and companies, teachers can create their own questions and explore multiple supports to empower their students. Using an equity lens challenge teachers to ensure

that examples and illustrations represent multiple perspectives; and challenge teachers to provide opportunities to deepen students' conceptual understanding, fluency, and problem solving. Teachers can use images, examples, and text that show a variety of cultures to illustrate mathematical thinking, mathematical problems, mathematical concepts. Guided by Ellerbrock and Vomvoridi-Ivanovic [6], consider power and participation, academic support, and using cultural and community assets as the basis for examples and tasks.

Text. Texts associated with literacy integration come in all forms. Stories, images, data, and books can provide scenarios for meaningful problem solving and cultural awakenings. Teachers can use current data and images as planned supports to create questions that illuminate their future students' insights into how mathematics is used in everyday media to create algebraic expressions that challenge how data is communicated. The following link provides insights into how businesses track young adolescent device use in order to market products. Teachers can write an algebraic expression to reflect the article. Teachers can then consider, "What would middle school students say?" https://screentimelabs.com/blog/how-advertisers-target-your-teens-smartphone-and-how-to-cope/ (accessed on 5 December 2022).

Cultural/Community Based Funds of Knowledge. As the population of students of color continues to rise in our schools, teachers need to present curriculum from multiple perspectives. Providing insights into other cultures provides a context that the world is a truly fascinating place full of beautiful stories and environments, artists, and mathematical phenomena. Teachers need to examine mathematics first, through their own culture and community assets, and then consider their own thoughts on how to present material. To promote equity in classrooms, they must be intentional about providing resources and opportunities to examine ways to promote a growth mindset for themselves and their students. A growth mindset is "the belief that intelligence is not fixed and can be developed" [37] n.p. Developing a growth mindset has been shown to be a predictor of achievement across all levels of socioeconomic status [37]. Dweck [38] provides encouragement for teachers to recognize that learning to teach takes time and that mistakes will happen; but over time, she states, we all get better at what we do. Therefore, teachers need to embrace a growth mindset as they learn to plan lessons with an equity focus.

Adolescent Literature as a support for engaging students in interdisciplinary thinking. Centering on literature is a great tool for creating interdisciplinary or integrated lessons. Literacy is a tool that provides students with "windows" into other worlds [38]. Using literature helps them develop their own skills for tapping into their backgrounds and experiences. Literacy addresses equity by "developing analyzation skills and content knowledge to intervene when biases arise; examining the connections between inequity and oppressive policies and practices that are occurring now; and rejecting the deficit view of marginalized populations from outcome inequities (e.g., suspension rates or test scores)" [39] n.p. Teachers can extend ideas and find books where students can see themselves and make connections to the mathematics curriculum. Using texts, teachers can empower students and promote participation with young adolescents. The following are examples of young adolescent and children's literature that may be incorporated in math lessons to promote equity in young adolescent learner's mathematical classroom learning experiences.

Hidden Figures [40], based on the popular movie by that name is a book that shares the contributions of African American women mathematicians, "Dorothy Vaughan, Mary Jackson, Katherine Johnson, and Christine Darden, who participated in some of NASA's greatest successes, like providing the calculations for America's first journeys into space. And they did so during a time when being black and a woman limited what they could do. But they worked hard. They persisted. And they used their genius minds to change the world. This book explores the story of four female African American mathematicians at NASA, known as "colored computers", and how they overcame gender and racial barriers to succeed in a highly challenging STEM-based career" [41]. Not only is this story inspiring to young mathematicians, teachers and students can relate real-life applications of mathematics.

Patterns in Peru [42] takes us on a South American adventure with hints of Incan history. Using the book in mathematics class, the teaching and learning of patterns and functions can come alive. The characters in Patterns in Peru are on an adventure using their own problem-solving skills to find their way using a series of patterns. The final pattern is a growing pattern which leads to a discovery of a vital detail of the adventure. Mathematically speaking, the discovery of this pattern opens a window to the importance of functions and how they work. The story-line naturally leads to opportunities for algebraic thinking with patterns and equations. To explore the growing pattern on the ancient wall from the story, students can use color tiles (physical or virtual manipulatives) to construct and model the puzzle posed in the adventure. In building the pattern, students discover how two variables consistently grow together, thus revealing a linear function. In analyzing the function, graphing adds another layer. Utilizing graphing calculators and/or DESMOS [43], students investigate the relationship between the variables and see the linear formation. Extensions of the constructions can include building tiles in various growing configurations such as an L-shape discovering the linear function $2x - 1$ and an H-shape for $5x + 2$. Empowering students even further, the teacher can facilitate the activity in such a way for students to share how their individual approaches to the problem may differ, but the resulting linear function remains the same. Graphic representations of patterns that are seen in the story can be constructed and support students' mathematical discourse.

One Grain of Rice [44] is a mathematical folktale, set in India, that offers opportunities for cultural explorations while investigating an exponential function. While connecting with the storyline, students experience how quickly Rani, the main character, cleverly earns rice from the raja. Rani suggests as her reward, "Today, you will give me a single grain of rice. Then, each day for thirty days you will give me double the rice you gave me the day before" (p.13). Students can discover the exponential function and write it algebraically. Physically building parts of the pattern with rice enhances the experience and captures elements of student engagement. Working collaboratively also supports students' social-emotional characteristics.

Math Curse [45] can inspire students to investigate the world through the beauty and wonder of mathematics with the bonus of the humorous perspective of a young adolescent. The authors spark students' interests by highlighting experiences through unusual questions. In the book, " . . . Mrs. Fibonacci says, 'You know, you can think of almost everything as a math problem'. On Tuesday, I start having problems" p. 2. We invite teachers to examine Math Curse and create mathematical expressions or equations to reflect ideas within the text. Algebraically speaking, an equation can be derived based similarly to the time management scenario presented in the book. For example, write an equation based on waking up at 6 and arriving at school by 8. Students can write an equation like $n + 6 = 8$ where n is the unknown amount of time. The equation is set up to illustrate the scenario mathematically. Statistically speaking, students can create a graph, similar to ones in the book, of how much time they spend each week on social media. Convert that number over a ten-year period. Using Math Curse as a base, teachers and their students can be inspired to create weird and wonderful math questions based on their own experiences and settings. For example, "The Mississippi River is about 4000 km long. An M&M is about 1 cm long. There are 100 cm in 1 m, and 1000 m in 1 km. Estimate how many M&Ms it would take to measure the length of the Mississippi River" [45] p. 12. Teachers and students can generate similar questions based on their personal surroundings or locations of prominence. For example, if the total shoreline of Myrtle Beach measures about 60 miles or 97 km, how many M&Ms would it take to measure the shore?

Literature integration can provide scenarios for simulations and explorations with mathematical manipulatives. These are great tools for engaging students in learning mathematics. Providing opportunities for active learning with manipulatives—algebra tiles, color tiles, geoboards, and more—provides a deeper understanding of concepts. Using manipulative tools physically or virtually can provide students with visual models to build conceptual understanding. Explorations with manipulatives provide opportunities

for student discovery and inquiry. In a culturally sustaining mathematics classroom we recognize the need to "play" and the importance of the "joy" of examining challenges [14]. When teachers incorporate student use of manipulatives, games and songs, these planned supports help students build conceptual understanding, as well as procedural fluency.

3.3.3. Place-Based, Problem-Based Learning

The third tool relates to using culture and surroundings as a framework for planning. A cultural lens must permeate our planning. Using a cultural lens can guide teachers in creating engaging lessons that highlight the cultural and community assets in their communities, their states, their regions, and the world. According to VanderArk, Liebtag, and McClennen [46] in *The power of place: Authentic learning through place-based education*, placed-based education embeds learning everywhere. It centers on individual learners, incorporates local and global thinking and requires design thinking to find solutions. For middle school teachers it can be interdisciplinary in nature, and should be inquiry-based to help students develop an understanding of their place in the world. This culturally sustaining practice addresses all the characteristics and the assets young adolescents bring to the mathematics classroom.

A pedagogical strategy that compliments placed-based learning is problem-based learning (PBL). PBL is a student-centered strategy that challenges learners to examine real-world problems [46–48]. Problem based learning encompasses five steps. Students must consider a problem, gather information and organize data, consider how students can be grouped, facilitate student work, help students communicate their findings, and assess the processes used [4]. It is our recommendation that teachers engage in research on PBL and participate in an experience before engaging with students.

Problem-based learning uses problems that young adolescents are interested in or are relevant to their communities, and are culturally centered. Place-based focuses specifically on the challenges or benefits that exist in a community. Very often problems are interdisciplinary. Discursive narratives in STEM, described as images, examples, and views not representing multiple cultures, discourages students of color from seeing themselves as scientifically minded [49,50]. Problem-based learning dismantles stereotypes and presents images and insights from multiple perspectives. Place-based learning encompasses the characteristics and assets of all students. Teachers can create opportunities for students to engage in collaborative problem solving, critical thinking, and dismantling of discursive narratives. The following examples illustrate the impact place and problems can have on students' problem-solving abilities.

Water Quality as a Place Based Activity. Water samples are collected from various rivers and streams and are labeled as separate villages. Students work in groups to perform an analysis on sample water from their village and compare it to results of the tap water from the school. They use Probeware to analyze pH, turbidity, dissolved oxygen, and conductivity. Each set of Probeware is set up at stations that students go to with their water samples. Their results are recorded on charts and on individual worksheets. Students make observations about their safe "village" water samples. If asked why they would not drink the water even though it tested safe, they could remark upon the debris floating in the samples. The lab continues with a filtration exercise. Students use a 2-L bottle (already cut), pea gravel, sand, and coffee filters to build a filtration device and test their village water. They compare the filtered water with a jar of the original, unfiltered sample. A discussion follows on how each material works as different levels of filtration (i.e.,: Why we would not use just pea gravel as a filter). The discussion continues with how "mother nature" naturally filters our drinking water via aquifers and how much of the drinking water we use every day comes from the ground rather than surface water.

Mapping the Coordinate Grid as a Problem Based Activity. This activity could be used in conjunction with students reading Hidden Figures and also reflects rockets that are being launched and returned to earth by NASA. The activity is called Coding with Texas Instrument Rover Robots and Coordinate Planes. Coding Mission: In order for you to

prepare for a safe lift-off to return to earth and receive the next colonists, you must get your rover to the launch pad site. The terrain on Mars is treacherous; consisting of mountainous regions, craters, and extreme sand storms. The trip to the launch pad will take 50 Earth days. The shortest distance to the launching pad will deplete half of the Rover's battery life since it is in the direct path of Martian sandstorms and the solar cells will not work. So, you must find a different path to take. The path to the launch pad must begin at the Communications Hub and include two stops to a re-cell station to charge the rover battery. The path must avoid the burial pit and must include a stop at the commissary to secure the food sources in case of a bad storm. Code a model path using Rover or Smartquriz that demonstrates the path the rover should take to get to the launch pad in time.

Epidemics. The impact of an epidemic is studied across many fields. Learning about the science of the virus helps us prevent and treat infections that cause epidemics and pandemics. We use math to see trends and track incident of infection during outbreaks. Social studies show us the history of epidemics and how historical factors affect the spread of contagious diseases. Literacy provides us a way to report information and what we have learned about a disease and its effects on a population. Students create a 3D model that uses each core subject (language arts, math, science, and social studies). On a cube, they must include the following information. First, they must choose a virus, bacterium, fungus, or parasite to study; name and draw or print a picture of the virus, bacterium, fungus, or parasite; share who discovered the disease and a brief history of that person; a map showing the areas of the outbreak; a write-up of the history of the disease; the difference between a pandemic, epidemic, and an outbreak; a description of the disease (what it is, how it is spread, what the symptoms are, and any treatment or prevention measures); a graph showing the trends of outbreaks over a period of time; and provide a citation paper of all sources used.

Using place/problem-based learning allows students to address concerns and values that exist within a community. The literature describes how lessons in STEM benefit the academic achievement for a range of students including English Language Learners and gifted students by intentionally broadening participation of all students [51–53]. Andreescu, Cordeiro, and Andreescu [53] talk about problem-based learning as "an approach with a deep respect for the value, abilities, and strengths of each student by raising expectations beyond the standard and providing guidance in a supportive environment" p. xviii. They describe problem-based learning as student-centric, highly collaborative, multi-levels of complexity, relies on range, rigor and resilience, and is fun. These elements relate directly to students' social, emotional, and psychological needs.

Students work collaboratively, on issues they deem critical, and have the potential to illustrate their own power in making a difference in their schools and communities. Place/problem-based lessons dismantle discursive narratives which often serve as barriers to broadening diverse students' participation in STEM. Both allow students to see themselves as scientists and mathematicians.

4. Discussion

Discussion: How These Strategies Support RMLMT

The tools described in this chapter: reflection, literacy integration, and the utilization of place-based/problem-based learning reflect three recommendations for middle grades mathematics educators. Once the authors examined and identified culturally sustaining practices, they returned to the three goals laid out by Ellerbrock and Vomvoridi-Ivanovic's [6] (Figure 1). A brief discussion in support of these goals follows.

Goal 1 addresses analyzing students' thinking [6]. This article addresses reflection, integrating literacy and using place-based/problem-based instruction to support student thinking, their cognitive demands, depth of knowledge, and mathematical discourse. Nieto [25] and Gay [26] assert that a culturally relevant view focuses on students' backgrounds much like Moll and Gonzalez [27] identify students' Funds of Knowledge. Each of these studies recognize cultural and community assets are critical for helping students gain confi-

dence in their own abilities. Using reflection, literacy, and problems are tools that engage and empower student thinking. Additionally, when teachers focus on their students' needs and intentionally build relationships in their classrooms, students have a better chance of succeeding [15,22]. When students have the opportunity to reflect on their cognitive demands they are learning to map their thinking. Mathematical autobiographies and journaling are tools that blend reading, writing, expressing, and thinking. These tools open students' ideas beyond coming up with an answer by inviting them to discuss their thinking, their challenges, and their successes. Using text to integrate mathematical phenomena gives purpose and personal insights to student work. And using tools that address local, regional and/or state problems, allow students to communicate their thinking in real life settings [6].

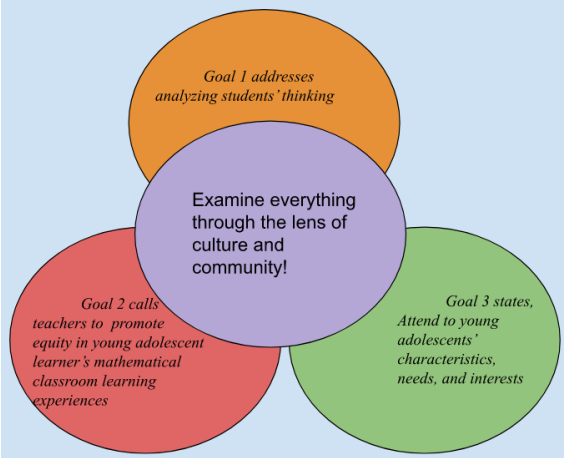

Figure 1. Goals for Culturally Sustaining Practices. Goals by Ellerbrock and Vomvoridi-Ivanovic [6].

Goal 2 calls teachers to promote equity in young adolescent learner's mathematical classroom learning experiences. When students have the opportunity to reflect on their own mathematical knowledge and insights, teachers empower them to see mathematics as real-world. Banks [4] discusses the importance of helping students be prepared for working in a diverse world. Reflection over time can show student growth as they learn to not only think and problem solve using critical thinking, but can also illustrate their own development of a growth mindset related to confidence and their insights into how math relates to their communities and cultures. This article supports the use of texts and literature to provide students with texts that relate to students' cultures but also to expose students to other cultures. Gorski's [13] and Muhammad's [14] work center on literacy in the classroom as a powerful tool for creating classrooms that are relevant, current, and purposeful. Using common texts, young adolescent literature, and other multi-media texts provides students with real-life examples. Using the art and language of multiple cultures can empower students. Muhammad invites teachers to, "tell stories and code knowledge into songs, chants, proverbs, and poetry, groups with a strong oral tradition record [to] sustain their cultures and cultural identities by word of mouth" [14] p. 28. Using problem-based thinking, students have the opportunity to address problems within the community and/or world that allows students to become problem solvers and agents of change. Each of these tools support students' use of and insights into academic language and communication that relates to students' cultures and funds of knowledge [6].

Goal 3 promotes attending to young adolescents' characteristics, needs, and interests. The final goal specifically relates to young adolescents. Each of these tools, reflection, literacy, and problem-based thinking, allows for students to express themselves and focus on their interests as well as the identities of others. Characteristics of young adolescents include their physical, cognitive, social/emotional, and moral characteristics [5]. Allowing students to move and to reflect on the needs in their perceived needs of the community,

state, and world address the physical characteristics and multiple cognitive interests of students. Hammond [17] shares the connection between written and oral traditions as tools to support how young adolescents gain information. Allowing students to connect with others is a skill they need. By focusing on cultural assets and community, teachers have the opportunity for "young adolescents [to] experience a deeper awareness of their social identities such as race, gender, social class, religion, sexuality, and immigration status" [5], (p. 63). Relating to current events in texts and literature sets the stage for students to investigate the needs of their communities. Each of the tools allows teachers to get to know their students' needs and to engage learners in multiple ways.

5. Conclusions

We chose to reference mathematical tools in this chapter as culturally sustaining. As educators we believe that a cultural lens must permeate all math planning as we help our students interrogate their own mathematical thinking, their own ways of knowing. Becoming culturally sustaining mathematics educators means teachers are intentional about getting to know young adolescents and helping them get to know one another. It is about helping students develop their own connections to mathematics in their current world and in the world they will one day lead. It is helping all of us interrogate examples, curriculum topics, and issues that communities face and helping our students use mathematics to illustrate inequities and possibilities. Becoming a culturally sustaining mathematics educator celebrates the imaginations of all our young adolescents.

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