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Math-Trivium Framework for Newcomer Students: Orientation for High School Teachers on Equitable, Inclusive Instruction

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Abstract: Newcomers, defined as students who have recently integrated into a new educational system, often face significant barriers to learning mathematics due to their diverse ethnic and linguistic backgrounds. Traditional mathematics instruction frequently overlooks the intrinsic, social, and cultural assets these students bring into the classroom. This oversight can hinder their academic success and integration into the educational environment. As ethnically and linguistically diverse student populations continue to grow across Western countries, there is a pressing need for mathematics lessons that reflect and leverage the varied backgrounds of all students. Additionally, teachers require proper preparation to respond effectively to the shifting demographics of their classrooms. This theoretical paper introduces the Math Trivium Framework, an asset-based approach to understanding newcomers' experiences in learning mathematics. By focusing on the intrinsic, social, and cultural strengths newcomers contribute, this framework aims to enhance their academic outcomes and integration. The paper emphasizes the importance of mathematics lessons that are inclusive of every student's unique learning background and highlights the necessity for teachers to (1) recognize and utilize these assets while also acknowledging and leveraging the various assets students are bringing into the classroom and (2) receive preparation to respond to the shifting population of students. Key components of the framework include shifting the focus from deficits to assets and glocalizing cultural relevance into mathematics for equitable and inclusive instruction. The Math trivium framework can promote equitable mathematics education that supports the academic success and cultural empowerment of all students, particularly newcomers navigating new educational environments.
Keywords: Math-trivium framework, Newcomers, Equitable Instruction, Asset-based Pedagogy and Inclusive mathematics instruction.

The educational system globally, especially in Western cultures, has experienced an unprecedented demographic change. Since the late 20th century, Western countries have seen increased immigration, particularly from non-Western nations (Hochschild & Scovronick, 2005). This has led to more diverse student populations in schools, and immigration has contributed significantly to this transformation (Ramona & Kelvin, 2016). For example, the recent statistics from the United Nations High Commissioner for Refugees (UNHCR, 2024) indicate that at the end of 2023, 43.4 million refugees globally were seeking refuge in Western countries, marking a threefold increase from the previous decade.

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The influx of immigrants and refugees, especially from non-western cultures, has led to increased diversity in the student population, bringing a wide range of cultural backgrounds, languages, and perspectives into Western classrooms, particularly in teaching and learning mathematics. This shift presents both challenges and tensions (Pollock et al., 2010) for mathematics teachers and newcomers, specifically related to ways to provide equitable mathematics instruction for this diverse student population. Mathematics is often perceived as a universal language. However, it is important to recognize that culture and language are intertwined and play a crucial role in students' mathematics learning (Brown & Strachan, 2022; Moschkovich, 2002). For example, students from different cultural backgrounds might approach problem-solving differently based on their prior experiences and the methods they have been taught. In some cultures, the use of storytelling and real-life scenarios is a common method to teach mathematical concepts, while others might focus more on abstract reasoning and rote learning. These cultural variations can significantly influence how students understand and engage with mathematical problems, highlighting the need for teachers to consider cultural contexts in their teaching practices. Teachers' knowledge of these cultural dimensions of mathematics learning is essential to understanding newcomers' mathematical experiences, as mathematics instruction should recognize the inseparable connection between culture, language, identity, technology, and mathematical understanding.

In this regard, high school mathematics teachers need to understand the experiences that newcomers bring with them when they immigrate to or seek refuge in Western countries and must be equipped with the knowledge and skills to support diverse classrooms, particularly in subjects like mathematics that often assume a one-size-fits-all approach (Kursav, 2022). The educational needs and success measurements in Western countries often differ from those in non-Western countries, especially countries from which newcomers immigrate. Students must often adjust to a new culture, language, and technology, as well as the issue of race, gender, or ability-based inequalities in identity (Aguirre et al., 2013; Artiles., 2003; Hatt., 2012). Additionally, there is the question of what hardships, for example, refugee students have gone through, such as socioeconomic challenges, interrupted education, and psychological issues that might affect their learning. For example, a refugee who had their safe spaces (family home, school) disrupted due to war or socioeconomic situations might display behavioral defiance or learning difficulties when they arrive at a new place of resettlement (McIlwain, 2017; Mupenzi, 2018). On the other hand, newcomers bring extremely diverse experiences, strengths, interests, and cultural and linguistic practices and attend schools alongside other youth from nondominant communities (Bal, 2014, p. 272). This underscores the complexity and diversity present in educational environments, necessitating a comprehensive understanding and support system for all students, particularly those who are newcomers to a new country and education system.

Culturally Sustaining and Relevant Pedagogy

A growing body of research has highlighted the significance of employing a culturally sustaining and relevant pedagogy (Paris & Alim, 2017; Ladson-Billings, 1995) and asset-based pedagogies (Celedón-Pattichis et al., 2018) to foster equitable and inclusive mathematics instruction for all learners from nondominant ethnic, racial, and linguistic backgrounds (Boaler, 2006; Civil, 2007; González et al., 2005; Ladson-Billings, 1995). This research has contributed to expanding and refining conceptions of equitable and inclusive mathematical instruction for immigrants. However, a predominant focus on the context of Latinx immigrants (e.g., González et al., 2005) or African Americans (Ladson-Billings, 1995) has characterized much of this research, overlooking the diverse experiences, knowledge, ideas, and assets that learners from other cultures or multilingual backgrounds bring into the classroom. Since racial identities do not fully encompass the range of cultural and linguistic diversity present among immigrant

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populations, there is a need for more comprehensive research that considers the multifaceted identities and backgrounds of all learners from an asset-based perspective.

In this context, educators know little about newly arrived immigrants and refugee students' identity formation in schools (Bal., 2009, 2014., Hos., 2020). I contend that as much as newcomers need language support, their cultural and academic identities and experiences are different, and there is a need to support teachers and school administrators in integrating newcomers into a new academic and social culture. For example, in the context of racial identity, understanding the complexities and nuances of how race intersects or is different from other aspects of identity, such as ethnicity and nationality, is crucial for creating inclusive learning environments that honor and validate the diverse experiences of all students. This approach can lead to improved student engagement and academic achievement as students feel more understood and supported in their educational journey (Gay, 2018). Additionally, students from refugee families may be left out of school because of the impact of socioeconomic issues they might have faced. Their experience might differ from other newcomer students who voluntarily migrated with their families to seek a better life (Verkuyten et al., 2018). Therefore, an asset-based pedagogy approach that acknowledges newcomers' diverse backgrounds and experiences is essential, and such an approach is the Math-trivium framework.

The Math-trivium framework is an asset-based framework that I developed to understand recent immigrant and refugee students' prior mathematical learning experiences and how those experiences intersect with their new culture. This framework recognizes the rich, diverse backgrounds these students bring to the classroom and emphasizes leveraging their prior knowledge and skills as an asset toward equitable mathematics instruction. It specifically focuses on the role of language, technology, and cultural perspectives in mathematics instruction. This framework builds on the trivium curriculum (D'Ambrosio, 1999), cultural knowledge (Rosa & Orey, 2015), and mathematics competency (Nissi & Højgaard, 2011, 2019).

The Math-trivium framework is grounded in culturally sustaining pedagogy (Paris & Alim, 2014) and culturally responsive teaching strategies and practices (Ladson-Billings, 1995), which has a powerful impact on identity development, social integration, and mathematics belonging (Bajaj & Bartlett, 2017). This asset-based pedagogy will help teachers become aware of students' potentially rich outside mathematical experiences. Additionally, it will enable teachers to develop various networks to support their academic and socioeconomic needs.

This theoretical paper aims to bring to the forefront an asset-based perspective of newcomers and explain how high school mathematics teachers can leverage such experience to create an equitable mathematics environment that can connect to their daily lives, home culture, and outside perspectives they bring in and outside the classroom. These perspectives will help teachers understand newcomers' mathematical interests and identities and create an inclusive and welcoming learning environment (National Academies of Sciences, Engineering, and Medicine, 2019).

Personal Perspective and Positionality Statement

As an immigrant from Africa currently pursuing doctoral studies in the United States, my personal and academic journey has profoundly influenced the development of the Math-trivium framework to understand the mathematical experiences of recent immigrants and refugees from an asset-based perspective. Understanding that having a good knowledge of refugee background is important, I have been volunteering for a refugee organization in Missouri, where I tutor refugee youths from Africa and Asia in mathematics and engage in classroom observations with refugee youths and their teachers in a public school.

These personal, educational, and professional experiences have influenced my journey toward understanding newcomers' experiences, especially within the context of mathematics education. Thus, I realized that while there is a growing body of literature on newcomers' education, the intersection of their mathematical experiences and education is notably understudied. This passion and concern have propelled me towards researching the mathematical experiences of newcomers, particularly in the United States, and how educators can leverage such experience as a pivotal role in social integration and empowerment. My positionality acknowledges the ways my identity, experiences, and background shape my research foci.

My identity as an African immigrant has provided me with unique insights into the tensions and challenges teachers face in diversifying classrooms (Pollock et al., 2010). This perspective drives my commitment to supporting middle and high school teachers in recognizing and valuing the diverse strengths and assets that students bring to the classroom.

During the Spring of 2023, I was invited by a refugee organization in Ohio to engage refugee instructors on a cross-cultural sensitivity program about some of the challenges they face while providing equitable instruction for refugee youths. During this program, most instructors raised many concerns about the tension they face in understanding refugee backgrounds and providing them with more equitable learning. This opportunity offered me a unique perspective to ponder how I can provide a solution to this challenge. Since then, the plight of refugee youth and their instructors has resonated deeply with me, not merely as a topic of academic interest, but as a fundamental human concern that transcends borders, cultures, and backgrounds.

What do we know about Newcomers and Learning Mathematics?

The term newcomer refers to anyone who is new to a place; for students, this usually refers to any student who was born abroad and is attending school in another country (Bajaj et al., 2022, p.186). This demographic encompasses a myriad of backgrounds, including immigrant students, refugees, asylum seekers, and individuals whose native language is not the dominant language of instruction. In the context of mathematics education, newcomer youths bring to the classroom different outside experiences, including varying linguistic, cultural, and educational backgrounds, such as limited or interrupted formal education (Suarez-Orozco et al., 2010). Additionally, within the classroom setting, newcomer youths grapple with internal experiences such as learner mathematics identities (Aguirre et al., 2013; Anderson, 2007).

Many newcomer youths come from regions such as the Middle East, Africa, and Central America, where communal living, strong family ties, and distinct social norms are prevalent. Upon arrival in Western countries, newcomers often face cultural differences, such as a higher emphasis on individualism, different communication styles, and variations in educational and societal structures.

The experiences of newcomer youths in mathematics education are intricate and often influenced by systemic inequalities within educational institutions. These students face not only the challenge of navigating a new language and culture but also the task of acclimating to a different educational system, which may operate on principles and pedagogies unfamiliar to them. Schools reproduce race, gender, language, or ability-based inequalities (for example, tracking) in a given society by privileging certain identities and their attendant ways of knowing, behaving, and being and marginalizing others (Artiles, 2003; Hatt, 2012). While schools are expected to facilitate the reintegration of newcomer youths into a new academic and social culture, they often lack the readiness to address these students' specific learning needs and identities (Hos, 2016). Yet, these students are expected, like other immigrant children, to adapt and assimilate to Western culture and discard (or at least mute and make secondary) their

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prior cultural heritage to function stereotypes and become more informed about western cultures and educational backgrounds (Kiramba et al., 2022).

According to Ndemanu and Jordan (2018), the lack of exposure to accurate and balanced information about, for example, African immigrants and refugees has often led to overgeneralizations, stereotypes, and misinformation about the continent and its people. This underscores the urgency of providing adequate support for high school teachers to understand the refugee experiences and identity as assets for equitable mathematics instruction. In this regard, Ndemanu and Jordan (2018) called on teachers of diverse students to deepen their cultural knowledge and competency, especially with respect to children of African descent, as a tool to combat stereotypes and become more informed about students' cultures and educational backgrounds. The authors stated that;

> *It is critical that teachers move beyond seeing their African immigrant students from a deficit lens to understanding their intellects and the rich frames of cultural and linguistic reference they bring to the classroom, which can enrich learning for all if properly exploited. (pp. 77-78)*

High school, mathematics teachers and school communities, often prioritize language acquisition as the primary need for newcomer youth integration, frequently overlooking the importance of an intersectional approach that includes cultural and educational practices. While language proficiency is crucial for effective communication and comprehension, it is not the sole determinant of academic success, particularly in mathematics. For instance, educators often overlook the intersectionality of language, culture, and diverse ways of learning mathematics, including the use of technology and cross-cultural connections.

Newcomer students bring with them a wealth of cultural knowledge and experiences that shape their understanding and approach to learning mathematics. Ignoring this intersectionality can lead to a disconnect between their prior knowledge and the new learning environment, hindering their academic progress (Shizha & Makwarimba, 2023). An intersectional approach recognizes that language proficiency alone is insufficient; it must be combined with culturally responsive pedagogies (Alim & Paris 2014; Gay, 2018) that acknowledge and build upon students' diverse backgrounds, learning styles, and mathematical tools and technologies with which they have familiarity.

Furthermore, an intersectional lens highlights the importance of creating learning environments that foster cross-cultural connections and dialogue. By embracing diverse ways of knowing and valuing different cultural perspectives in mathematics, teachers can create inclusive spaces where refugee students feel validated and empowered to engage with the subject matter. This approach not only enhances their learning experiences but also promotes a deeper understanding of mathematics as a universal language that transcends cultural boundaries (Edosomwan & Williams, 2024).

The notion of treating students' diverse backgrounds and experiences as valuable assets rather than deficits is central to asset-based pedagogical practices (Paris 2012). In the context of high school mathematics education, this approach becomes crucial for effectively engaging newcomer youths and facilitating their success in the subject. However, for this approach to be successful, it requires high school mathematics teachers to be adequately prepared and adaptable in implementing asset-based pedagogies tailored to the needs of newcomer youths. Addressing these challenges requires a commitment to asset-based pedagogy across the school learning community, which can inform the development of tailored pedagogical strategies, curricula, and support systems that account for the intersectionality of language, culture, and diverse learning approaches, including the use of technology and cross-cultural connections, ultimately helping to reduce tension between teachers and students.

Asset-Based Pedagogy for Effective Mathematics Instruction of Newcomer Students

A growing body of research has drawn attention to aspects of using asset-based pedagogy posited towards creating equitable and inclusive mathematics instruction for all learners from nondominant ethnic, racial, and linguistic backgrounds (Boaler, 2006; Civil, 2007; Ladson Billing, 1995; González, Moll, & Amanti 2005). This research has expanded and refined (to some degree) our conceptions of equitable and inclusive mathematical instruction for newcomers. However, this research does not address the experiences, knowledge, ideas, and assets newcomers bring into the classroom. Since racial and cultural background can complicate the process of assimilation (Abramitzky., 2017), I argue that it is less known how teachers should be prepared to meet the unique needs of newcomers in mathematics lessons. In this context, mathematics teachers should be aware of the potentially rich cultural mathematical experiences students bring from their lives and prior schooling and develop various networks and support structures for mathematics learning that students may be bringing to school (Ericka, 2016; Darboe, 2003). To effectively bridge this gap, it is essential to provide culturally sustaining professional development for teachers (Paris & Alim, 2017). Such training should help educators recognize the rich cultural mathematical experiences students bring from their lives and prior schooling and how these experiences can be leveraged to enhance their mathematical understanding. This professional development should focus on equipping teachers with the tools to create inclusive learning environments that honor and build on students' diverse identities and competencies, fostering a more responsive and supportive classroom dynamic for all students. In this regard, Teachers must be equipped with the knowledge and skills to connect students' cultural and linguistic backgrounds to their learning, especially in subjects like mathematics, which often adopt a one-size-fits-all approach (Kursav, 2022).

Culture and language are intertwined and play a crucial role in students' mathematics learning (Moschkovich, 2002), problem-solving strategies, mathematical reasoning, and mathematical identities and beliefs (Lee, 2007; Nasir & Hand, 2006). Teacher knowledge of these cultural dimensions of mathematics learning is essential to understanding newcomers' mathematical experiences. Thus, mathematics instruction should recognize the inseparable connection between culture, language, technology, and mathematical understanding. Traditional approaches to teaching mathematics often prioritize a narrow set of mathematical concepts and problem-solving strategies, which may not resonate with or reflect the lived experiences of all students, particularly those from marginalized or underrepresented backgrounds. Integrating asset-based pedagogy into mathematics instruction can involve including culturally relevant examples (Ladson Billings, 1995), preparing mathematics instruction to draw on students' funds of knowledge (González, Moll, & Amanti, 2005), or helping meet the specific needs of diverse student populations and promote active participation in classroom instruction (Umeh & Rosa, 2022).

Empirical findings on asset-based pedagogy provide substantial evidence of its positive impact on student learning and engagement. For instance, González, Moll, and Amanti's (2005) *Funds of Knowledge* study demonstrated how incorporating students' cultural and home experiences into lesson plans enhanced academic outcomes and fostered meaningful connections between students and teachers. Similarly, Civil (2007) found that leveraging community knowledge in mathematics instruction not only improved students' mathematical understanding but also promoted equity and inclusion. Boaler (2006) illustrated how student-centered, culturally responsive teaching strategies created respectful learning environments where diverse learners thrived. These findings align with the goals of the Math Trivium Framework, which emphasizes the importance of recognizing students' cultural and linguistic assets to create inclusive and effective mathematics instruction.

Therefore, asset-based pedagogies reject deficit-based approaches that view "the

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languages, literacies, and cultural ways of being of many students and communities of color as a deficiency to be overcome in learning the demanded and legitimized dominant language, literacy, and cultural ways of schooling" (Paris, 2012, p. 93). Instead, these pedagogies position students' languages and cultures as valuable to maintain and resources upon which to build additional knowledge (Paris, 2012). For example, teachers can incorporate culturally relevant examples and multilingual resources, which validate students' identities and make mathematics more accessible and meaningful (Moschkovich, 2013).

Research demonstrates that asset-based pedagogy not only improves students' mathematical understanding but also fosters a more inclusive and supportive classroom environment (Celedón-Pattichis et al., 2017; Civil & Hunter, 2015; Hos., 2016, 2019; Hos et al., 2020). This approach enables teachers to create lessons that connect mathematical concepts to students' real-world experiences, making learning more relevant and engaging. It helps newcomer students develop confidence and a positive mathematical identity, which are crucial for their academic success (Aguirre & Zavala, 2013).

Creating a supportive classroom environment, establishing effective daily routines, and implementing thoughtful teaching interventions are essential for aiding newcomer students' mathematics instruction. From an asset-based pedagogy perspective, teaching mathematics through a culturally responsive lens involves leveraging students' funds of knowledge (González, Moll, & Amanti, 2006) to connect mathematical concepts to their lives and interests. Teachers can use real-world problems that resonate with students' cultural backgrounds or incorporate examples from their everyday experiences. For example, calculating the cost, measurements, distance, and time involved in culturally relevant scenarios can significantly promote equitable and inclusive mathematics instruction for diverse learners.

Additionally, allowing students to discuss mathematical ideas in their native languages or use cultural methods of problem-solving facilitates deeper understanding and validates their experiences. By integrating these strategies, teachers enhance mathematical comprehension, build a more inclusive and engaging learning environment, and promote cross-cultural values and the exchange of ideas between students and teachers. This approach respects learners' unique experiences and backgrounds, fostering empowerment and cultural inclusivity (Freire, 1970).

In this regard, I propose the Math-trivium Framework, an asset-based pedagogy that highlights the rich cultural resources newcomers bring from their homes, communities, and cultural contexts. High school mathematics teachers and the school community can leverage this framework to provide equitable mathematics instruction and inclusive learning for newcomer youths. The Math-Trivium Framework encourages teachers to incorporate students' cultural knowledge and real-world experiences into their lessons, ensuring that all students see the value and applicability of mathematics in their own lives. This framework also promotes continuous cross-cultural collaboration between teachers and students, encouraging the exchange of ideas and perspectives, which enriches the learning experience for newcomers and reduces tension between the teacher and student. I contend that implementing equitable mathematics instruction using a Math-trivium framework can ensure that all students can access comprehensive and inclusive mathematical content regardless of their background or learning styles. It involves creating a learning environment that reflects, acknowledges, and celebrates the diversity of students' cultural backgrounds and experiences, offering examples and contexts that resonate with their lived realities (Buckley, 2010).

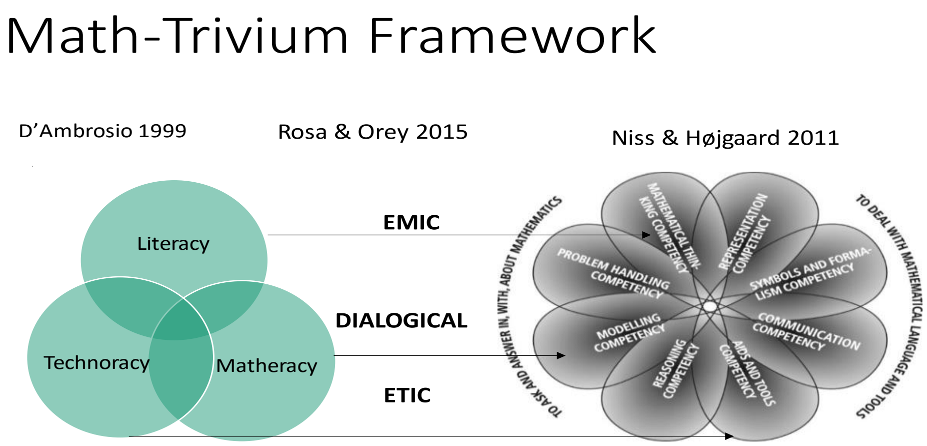
Theorizing Math Trivium Framework for Equitable Mathematics Instruction

The Math-trivium framework offers a comprehensive approach to newcomer learners' mathematics instruction that extends beyond traditional instructional methods. Rooted in the principles of culturally sustaining pedagogy (Paris & Alim, 2014), this framework recognizes the importance of honoring students' cultural backgrounds and experiences from an asset-based perspective. Culturally sustaining pedagogy (Paris & Alim., 2014) moves beyond simple cultural relevance in pedagogy to supporting the cultural experiences of minority youth; that is, it "seeks to perpetuate and foster—to sustain—linguistic, literate, and cultural pluralism as part of the democratic project of schooling" (Paris, 2012, p. 95). Culturally sustaining pedagogy exists wherever education sustains the lifeway of communities that have been and continue to be damaged and erased through schooling (Alim & Paris, 2017, p.1). In this regard, Paris and Alim's (2014) culturally sustaining pedagogy (CSP) prioritizes two fundamental principles: firstly, acknowledging the diverse and dynamic nature of youth identity and cultural expressions and secondly, recognizing the potential of youth culture to challenge dominant narratives while simultaneously critiquing its role in perpetuating systemic injustices.

The purpose of the Math-trivium framework is to provide a lens through which high school mathematics teachers implement asset-based pedagogical practices for addressing the unique needs and challenges faced by newcomer youths. The framework provides cross-cultural educational experiences that promote mathematical success and well-being among newcomer youths, empowering them to thrive inside and outside the classroom. The Math-trivium framework (see Figure & Appendix 1) integrates the elements of trivium (D'Ambrosio, 1999; Rosa & Orey, 2011), Mathematics Competency (Niss & Højgaard, 2011; Niss & Højgaard, 2019), and Ethnomodelling (Orey & Rosa, 2015) to balance diverse knowledge and mathematical proficiency (Umeh & Rosa, 2022). This framework explores newcomers' communicative instruments (literacy), way of mathematizing (Matheracy), and the tools and technology (technocracy) that they use to do math in their home culture, with each of these elements rooted in cultural knowledge (Rosa & Orey, 2015).

For example, in the context of the United States, to be mathematically competent, newcomers must use English as a communicative language and adapt to a new system with more/different technological tools from their home country. Also, sometimes, the mathematization in the new system differs from how they mathematized in their home culture. For example, in some cultures, the method of mental math calculation may differ significantly from the standard algorithms taught in Western mathematics education. For instance, methods like mental calculation strategies or traditional counting systems could present variations in how mathematical concepts are approached and applied compared to methods taught in Western educational systems.

Figure 1
Shows the Math-trivium connection between the trivium and mathematical competencies through Ethnomodelling.



Elements of the Math Trivium Framework

The Math-trivium framework encompasses a dynamic triad of language, technology, and mathematical experiences, synergistically enhancing equitable mathematical instruction. This framework explained the cultural connections between Ethnomodelling (Rosa & Orey, 2015), the concept of the trivium (D'Ambrosio1999), and mathematics competency (Niss & Højgaard, 2011; Niss & Højgaard, 2019). For the rest of this paper, I will explain extensively the concept of the Math-trivium framework and how it is connected to language, technology, culture, and mathematical experiences.

The Concept of Trivium

The trivium (D'Ambrosio, 1999) emphasizes the need to develop school activities based on an ethnomathematics foundation. In this regard, D'Ambrosio emphasizes that mathematics instruction should composed of literacy (communicative instruments), Matheracy (analytical instruments), and Technoracy (material and technological instruments), which I describe below.

1. *Literacy*: From the literacy perspective, high school mathematics teachers and students elucidate abstract notions, construct logical arguments, and communicate mathematical insights. For example, communicative instruments such as texts, numbers, graphs, tables, media, the internet, and technological tools combine to develop technocracy competencies to process, mediate, shape, and embody this information.
2. *Matheracy*: The ability to interpret, manipulate, and manage signs, symbols, and codes, as well as to propose the elaboration and use of mathematical models in everyday life related to diverse environments, is essential for utilizing procedures and strategies developed within a cultural context (Rosa & Orey, 2015)
3. *Technoracy*: It is the incorporation and use of diverse tools, including calculators, computers, software, computational programs, artificial intelligence, and simulators, which enhance the development of mathematical competencies that are also found in the practices developed by the members of the school community (Rosa & Orey, 2013).

The Concept of Ethnomodelling

Ethnomodelling emphasizes the organization and presentation of mathematical ideas and procedures developed by the members of distinct cultural groups to facilitate communication and transmission across generations, which adds cultural aspects to the modeling process. In this regard, these members construct models of mathematical practices found in sociocultural systems, which link cultural heritage with the development of mathematical practices (Rosa & Orey, 2015). This approach helps the organization of pedagogical action in classrooms by using emic (local), etic (global), and dialogical knowledge used to enable the understanding of systems taken from the reality of the members of distinct cultural groups (Rosa & Orey, 2013b), which I describe below.

1. *Emic Knowledge*: is based on mathematical concepts rooted in cultural features of mathematical phenomena within a specific cultural context to understand it as its members do. For example, cultural beliefs.in many African cultures, mathematical concepts are deeply embedded in cultural practices, art, and daily activities. In the Yoruba culture of Nigeria, there is a rich tradition of using geometric patterns in textiles, pottery, and wall decorations. One specific example is the adire fabric, which features intricate patterns created using a resist-dyeing technique. Also, the traditional methods of counting, measuring, and geometric design often reflect

unique cultural understandings of mathematics. This shows that mathematical knowledge developed by members of a specific cultural group consists of abstract symbol systems and is the consequence of historical-cultural events and unique internal logic, where people have developed, accumulated, diffused, and learned instances and definite usages of symbol systems (Rosa & Orey., 2015).

2. *Etic Knowledge* refers to constant mathematical phenomena worldwide that do not vary across cultures. Some mathematical techniques, strategies, and concepts are generalizable across cultural groups, and the general idea of mathematical practices is considered a universal phenomenon (Rosa & Orey, 2013). For example, this includes checking prices, times schedules, code-switching, using the units of measurement, performing mathematical operations, and interpreting graphs and tables. Technological tools for learning and understanding the nature and rules of formal mathematical systems (including procedures, syntax, and semantics) are all rooted in etic knowledge.
3. *Dialogical Knowledge*: uses emic and etic knowledge to understand dialogue processes and dynamics of encounters between cultures. Traditional concepts of emic and etic knowledge are essential points of view for understanding and comprehending cultural influences on newcomers' perspectives through the development of mathematical language and technological models. While the mathematical language model helps the teacher to understand mathematical procedures that differ within a distinct culture through the use of dialogue, the technological model helps the teacher to create a bridge in understanding this procedure and further justify understanding complex knowledge as an essential point of view for comprehending the cultural influences of newcomers' experiences. Teachers can implement dialogical knowledge in their teaching for newcomers by using technology, including artificial intelligence and multimedia tools such as YouTube like Google Translate, to analyze and interpret language content for multilingual learners. They can also utilize self-assessment tools as reflective instruments to enhance communication and collaboration among newcomer students, for example. Teachers can use reflection journals, mind mapping tools, and blogs as self-assessment tools to encourage newcomer youths to maintain a digital journal where they regularly reflect on their progress and understanding of mathematics, connecting their learning to their home experiences and cultural context.

The Concept of Mathematics Competency

Mathematical competencies are the ability to develop and apply mathematical thinking to solve a range of problems in everyday situations; it is important to emphasize the process, activities, and knowledge. Mathematical competence involves, to different degrees, the ability and willingness to use mathematical modes of thought (logical and spatial thinking) and presentation (formulas, models, constructs, graphs, and charts). Niss and Højgaard (2012) state that mathematical competence is the ability to understand, judge, do, and use mathematics in various intra (emic) and extra (etic) mathematical contexts and situations in which mathematics plays or could play a role.

Niss and Højgaard (2012) identified eight competencies divided into two groups. The first group refers to the ability to ask and answer questions in and with mathematics, which comprises mathematical thinking, problem handling, modeling, and reasoning competencies. The second group refers to the ability to deal with mathematical language and tools comprising representing, symbolism and formalism, communicating, and aids and tools competencies.

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What are some practical ways Teachers can apply the Math-trivium framework in Newcomer Classrooms?

In this section, I will highlight practical examples of the Math -trivium Framework and provide actionable strategies for teachers to implement its principles in diverse classroom settings to support equitable and inclusive mathematics instruction. The Math-Trivium Framework offers a comprehensive approach to teaching mathematics that can be effectively implemented in newcomer classrooms, which often have students from diverse cultural backgrounds and with varying levels of prior mathematical instruction. Culture and language play crucial roles in the learning experiences of newcomer students (Samway et al.., 2020; Suárez-Orozco et al., 2009). The Math-trivium framework provides a cross-cultural learning approach that enables the school community to reconfigure the relationship between cultures, language, mathematics, and technology. For example, numerical relationships observed across various societies demonstrate that different cultures have their own methods for measurement, classification, calculation, gaming, divination, navigation, astronomy, modeling, and a diverse array of other mathematical processes employed in the creation of cultural artifacts (Eglash et al., 2006). In this section, I theorize some practical ways teachers can leverage the Math-trivium framework in providing equitable mathematics instruction for newcomer youths.

Literacy and its Connection to Cultural Knowledge and Mathematics Competency

Researchers have advocated for translanguaging pedagogy as a means for teachers to provide equitable instruction (Cummins, 2019; Lang, 2019; Yilmaz, 2021). While this approach has helped reduce linguistic tensions between teachers and newcomer students, I argue that it has not been without its challenges in bridging the gap when it comes to balancing the language of instruction, especially in classrooms with diverse learners. This is because newcomers come from diverse educational backgrounds and learning experiences; for example, the learning experiences of refugees might be different from other immigrant students due to interrupted formal education (Custodio, & Loughlin, 2017), and it is important for teachers to understand the background each learner is bringing to the classroom. From my experience observing teachers and newcomer students, I noticed that at times, when teachers translate the language of instruction into students' native languages, many students might find it difficult to read mathematical expressions. This is because online translation tools like Google Translate and chatbots often do not provide accurate phonetic representations of the non-dominant language.

In this context, using the literacy component of the Math-Trivium Framework in a newcomer classroom occurs through open communication, self-awareness, active learning, and mutual understanding, facilitating the exchange of ideas and perspectives among individuals from different cultural backgrounds (Amery, 2020; Havis, 2020; Jurkova, 2021; Umeh & Rosa, 2022). For example, in learning word problems and mathematics concepts such as counting, data interpretation, and statistics, using the literacy component of the Math-trivium framework, teachers can encourage newcomer students to read and interpret mathematical word problems or instructions in their native languages or encourage students who might have interrupted education (e.g., refugees) to discuss and explain their understanding of the mathematical problem or data with classmates who share the same linguistic background. With this, teachers not only validate students' linguistic backgrounds but also help build their confidence and engagement with mathematical concepts. Additionally, incorporating culturally relevant examples, for instance how students construct word problems in their various contexts when learning units of measurement, data interpretation, or problem-solving techniques, can make the content more relatable and accessible for newcomer students. Then, students can translate and present their interpretations to the whole class in the classroom language, fostering communication and collaboration skills. This approach will help newcomers build mathematical and communication competence by understanding others' written, visual, or oral 'texts' about matters having mathematical content in multilingual contexts. Also, students can express mathematical concepts at different levels of theoretical and technical precision in oral, visual, or written form. As newcomers engage in this collaborative and culturally responsive approach to mathematics education, they develop not only mathematical proficiency but also the ability to navigate and thrive in multilingual and multicultural environments, a valuable asset in today's increasingly interconnected world.

Matheracy Component and its Connection to Cultural Knowledge and Mathematics Competency

The Matheracy component bridges the gap between mathematical competency and cultural knowledge, emphasizing the importance of the integration of cultural knowledge and practices into mathematics instruction. Cultural knowledge, encompassing the mathematical ideas and practices embedded in various cultural contexts, reveals that mathematical thinking is not confined to any single tradition but is a universal human endeavor expressed in diverse ways across different cultures (Nasir et al., 2008). In this regard, by incorporating culturally relevant mathematical practices, teachers can make mathematics more accessible and meaningful to newcomers and students from diverse backgrounds. The use of cultural knowledge in mathematics instruction has been shown to enhance students' engagement and understanding of mathematical concepts (Abdulrahim & Orosco.,2020; Leonard, 2018; Mania & Alam, 2021). For example, utilizing geometric patterns found in traditional textiles or architectural designs from various cultures can illustrate abstract concepts like symmetry, transformation, and scaling in a tangible and relatable manner (Civil, 2007). This approach not only helps students see the relevance of mathematics in their daily lives but also acknowledges and values their cultural experiences, fostering an inclusive learning environment that respects and builds upon their cultural knowledge of mathematization.

The process of mathematizing mathematical concepts and the tools utilized for mathematization vary across cultural contexts. In comparing the mathematics context of Western to non-Western cultures, significant differences exist not only in the pedagogical approach but also in mathematics expression and use of word contexts in mathematical tasks. Although numbers are objective in a global stance, for example, $2 + 2 = 4$, and arithmetic operations (addition, multiplication, division, and subtraction) are universal, the ways in which these numbers are intertwined in the language of mathematical expressions differ across cultural contexts. Different countries use various systems of measurement for distances, size, temperature, height, weight, and directions. I argued that these expressions are rooted in mathematical concepts such as word problems and have deeper cultural and historical implications.

A key difference between the Western and non-Western ways of learning mathematics lies in the teaching approach. In some Western cultures, for example, in the United States, there is often an emphasis on individual problem-solving and abstract reasoning (Schoenfeld., 2007), while many non-Western cultures focus more on collective learning and practical application of mathematical concepts. For example, Japanese mathematics instruction emphasizes problem-based learning, where students explore multiple methods to solve a single problem, fostering a deeper understanding and flexibility in thinking (Takahashi, 2006). Also, some African cultures are focused on communal-based learning, where cultural artefacts are used to engage students in learning mathematics (Eglash., 1999; Nkopodi, & Mosimege, 2009). In African cultures, Ndebele patterns with intricate geometric designs can teach students about symmetry, geometry, and fractions. Ethiopian Genna, a traditional game similar to hockey, can be used to explore angles, velocity, and geometry through gameplay analysis. Navajo weaving in Native American cultures allows students to study symmetry, patterns, and algebraic thinking

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by recreating complex geometric designs. Islamic geometric art from the Middle East, found in architecture and textiles, helps students learn about symmetry, tessellation, and polygon properties.

Additionally, the linguistic context in which mathematics is taught and understood varies widely. In many non-western languages, the structure of number words and the logical formation of counting systems can facilitate a more intuitive grasp of mathematical concepts at an early age. The body-part counting system is a numeral system that uses body parts to extend counting beyond ten fingers. It is used in some languages, such as those of New Guinea and Australia, to create higher base counting systems up to base-27. In these systems, the names of body parts are used instead of words for each number. For example, in the Oksapmin people's base-27 system (Fedden, 2012; Roth, 1999), the fingers are counted as 1 through 5, then counting continues up the arm, with the wrist as 6, mid-forearm as 7, neck as 11, an ear as 12, an eye as 13, and the nose as 14. Counting then continues back down the other side of the head, neck, and arm to the fingers on the other hand, which are counted 23 through 27. Also, the Mayan number-naming system is highly regular and directly reflects the base-10 system, which may contribute to more straightforward learning of arithmetic for young children (Magaña, 2010, 2013).

Cultural attitudes towards mathematics also play a significant role. In some cultures, mathematics is seen as a critical tool for daily life and economic development. Most non-western culture places much emphasis on mathematics involved in everyday interactions, particularly in markets and trading activities. For example, when negotiating prices, buyers and sellers use mental arithmetic to determine fair values, considering factors such as supply and demand, quality of goods, and market trends (Saxe, 1988). Bargaining involves calculating percentages, fractions, and sometimes even basic algebra to arrive at mutually acceptable prices. In an African setting, prices for commodities are often negotiable, and the exchange of goods typically occurs through cash transactions. Furthermore, handling cash transactions requires numerical skills, including addition, subtraction, multiplication, and division. Buyers must accurately count their money and calculate change, while sellers must calculate totals and manage their inventory and finances effectively. This activity demonstrates that mathematics is deeply embedded in everyday interactions, particularly in market and trading activities. These real-world scenarios are often used to teach students, especially through word problems.

However, in a Western context, prices are typically fixed rather than negotiable, reducing the need for bargaining skills. Cash transactions are increasingly supplemented by electronic forms of swiping payment, such as credit cards, debit cards, and digital wallets. This shift reduces the immediate need for mental arithmetic in calculating change but requires understanding concepts like interest rates, credit limits, and electronic transaction fees. These differences might be some of the nuances that newcomers might navigate as they adapt to the economic landscape of the Western world, where the reliance on fixed prices and electronic transactions alters their traditional way of engaging in everyday mathematics. When teachers are encouraged to examine mathematical activities in students' sociocultural contexts, they realize that mathematics procedures and practices are not trivial; instead, they become aware of the profound connections these concepts hold with students' daily lives, both within and outside the school environment.

Technoracy and its Connection to Cultural Knowledge and Mathematics Competency

The technoracy component of the Math-trivium framework involves the integration of technological tools, manipulatives, and visual aids, which plays a crucial role in enhancing cultural knowledge and mathematics competency among newcomer students. Technology can help students visualize abstract mathematical concepts, make connections between mathematical ideas, and actively engage with the mathematical concepts (Rashidov, 2020), which can lead to increased student engagement, interest, and motivation in learning mathematics (Bright et al., 2024). This statement resonates with the importance of technology in learning mathematics in both Western and non-Western cultures. However, differences exist between Western and non-Western cultures in the use of technology and manipulatives in learning mathematics, and the process of mathematizing mathematical concepts and the tools utilized for mathematization vary across cultural contexts.

In comparing Western to some non-Western cultures, significant differences exist in the availability and usage of technology and tools for mathematical tasks. While Western cultures generally have more access to advanced technological resources such as graphing and calculation tools, educational software, and online resources, many non-western cultural regions may face challenges related to limited access to modern technology and may rely more heavily on traditional tools and oral pedagogy in problem-solving and learning mathematics.

Furthermore, traditional practices and indigenous knowledge systems can influence mathematical understanding and applications. For instance, many African cultures have rich traditions of mathematical thinking embedded in art, architecture, and navigation, which are often overlooked in Western-centric educational frameworks. For example, the mathematization of the people of Tipi as a pedagogical approach to elaborate activities for the teaching and learning of mathematics shows the importance of contextualizing problems in the learning environment by connecting culturally relevant pedagogy concepts (Rosa & Orey., 2019). Similarly, the use of traditional abacuses in countries like China and Japan (Miller., & Stigler, 1987) provides a tactile and visual method of learning arithmetic that differs from the typical Western reliance on calculators and digital tools.

From my observation working with refugee youths in a refugee organization and conversing with their teachers, I noticed that some recent African and most Asian multilingual learners come from an environment where technology is limited or inaccessible. This limited access to technology, such as the inability to effectively engage with digital learning platforms, navigate online resources, and develop essential computer literacy skills for mathematics instruction, can create barriers to their mathematical success. In this context, I contend that teachers should not only be mindful of their students' diverse linguistic or mathematical backgrounds but also pay attention to their technological needs. To achieve this, teachers must continuously engage newcomers in digital literacy and cross-cultural interactions using technological models to address these challenges for equitable and inclusive mathematics instruction.

The technological model (Libbrecht & Goosen, 2016; Dubinina et al., 2022) helps teachers bridge the gap in understanding various cultural mathematical procedures. This model helps elucidate the complexities of knowledge within different cultural contexts, facilitating a fundamental understanding and contributing to comprehension of the cultural influences on the experiences of multilingual learners. Technology tools such as Google Translate, Khan Academy, GeoGebra, Demos for graphing, YouTube, and artificial intelligence such as chatbot and WolframAlpha foster cross-cultural knowledge by enabling communication, collaboration, and cultural exchange among individuals from diverse backgrounds. For instance, teachers can utilize technology and artificial intelligence to analyze and interpret language content, aiding multilingual learners in understanding complex concepts. Showing willingness to learn and understand newcomer students' culture using multimedia platforms such as YouTube offers opportunities to enrich knowledge exchange and provides diverse resources for learning.

For example, learning about the type of music or movies from students' culture that excites them or a particular game they like to play can be relevant to learning mathematics and can be a gateway to making mathematical concepts more relatable and engaging. Additionally, teachers can encourage multilingual students to build relationships and be open to sharing areas of concern or misconceptions; moreover, employing self-assessment tools can serve as reflective instruments, enabling multilingual students to enhance their communication and collaboration skills autonomously. This approach not only honors students' diverse backgrounds and experiences but also provides a platform for inclusive participation in the evolving landscape of their resettlement journey.

Limitation

This article presents the Math-trivium framework as a theoretical model to enhance equitable and inclusive mathematics instruction for newcomer students by leveraging their cultural, linguistic, and technological assets. However, its lack of empirical validation remains a significant limitation, as it has not been tested in real-world classroom settings to evaluate its effectiveness in improving student outcomes. Additionally, while the framework highlights the strengths and assets of newcomers, it does not adequately address critical challenges such as trauma, interrupted education, and systemic barriers that often hinder their integration. These gaps highlight the need for further research to explore the practical implementation and adaptability of the framework in diverse educational contexts.

Final Consideration

This paper presents an asset-based framework for understanding newcomer students' mathematical experiences. Also, it provides leverage for teachers to understand these experiences and help students attain success in mathematics. The Math-trivium framework can be used to meet the specific needs of the diverse student population, as well as the desired learning that may help them become active participants in classroom instructions and activities. Teachers can create inclusive and effective learning environments by recognizing and leveraging students' diverse cultural, technological, mathematics, and linguistic backgrounds, fostering a deeper understanding of mathematical concepts and promoting equity and diversity within the classroom.

The framework underscores the importance of equipping teachers with the necessary skills and knowledge to effectively address the shifting demographics of student populations. By focusing on leveraging the social, cultural, and intrinsic assets that newcomer students bring to the classroom, the framework aims to create a strengths-based approach to mathematics instruction. Implementing this framework is essential to bridge the gap between theory and practice, fostering more equitable and inclusive mathematics instruction for newcomer students. Practical application in real-world classroom settings would provide an opportunity for empirical validation, enabling educators and researchers to assess its effectiveness in harnessing students' cultural, linguistic, and technological assets.

Continuing efforts to implement and refine the Math-trivium Framework have the potential to create empowering and transformative learning experiences that support the success and integration of diverse learners. Although this paper does not delve deeply into critical challenges faced by newcomers, such as trauma, interrupted education, or foundational knowledge gaps, it highlights the importance of recognizing and utilizing students' assets to foster a positive and inclusive learning environment. Future research can build on this foundation by examining how these challenges intersect with the framework, offering a more comprehensive perspective on newcomer students' experiences and enhancing the framework's ability to address their unique needs effectively.

Endnotes

(1) Newcomers refer to anyone new to a place; for students, this usually refers to any student who was born abroad and is attending school in another country (Bajaj et al., 2022, p.186). This demographic encompasses a myriad of backgrounds, including immigrant students, refugees, asylum seekers, and individuals whose native language is not the dominant language of instruction.

(2) Equitable mathematics instruction is the simple understanding that students and communities come from different backgrounds and may have different ways of being and thinking, even in math.

(3) Mathematical experiences, in the context of this paper, recognizes the outside and inside knowledge students bring into the classroom.

(4) Models in terms of emic, etic, and dialogical knowledge represent tools for understanding cultural phenomena, with emic focusing on insider perspectives, etic on outsider perspectives, and dialogical knowledge incorporating both in a dynamic, reciprocal process of understanding.

(5) Multilingual learners are students who speak one or more languages other than English at home.

(6) Mathematics success is not defined by quantitative test scores. Rather, it relies on a more holistic demonstration of mastery and competency of knowledge and skills that are useful, relevant, and foundational for students' future aspirations.

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Appendix

Math-trivium Framework

Literacy (Communicative instruments) Competencies create and process information that allows individuals to manage daily routines successfully. a) Applying reading, writing, representing, and calculating techniques in diverse media contexts. checking prices, times, and schedules, use units of measurement, perform mathematical operations, and interpret graphs and tables. **Mathematical Competencies** ● 1st Group Mathematical thinking ● 2nd Group Communicating Representing **Emic knowledge** This knowledge is based on mathematical concepts rooted in cultural features of mathematical phenomena within a specific cultural context to understand it as their members comprehend it.	**Matheracy (Symbolic and analytical instruments)** Competencies to interpret signs and codes and to propose and use mathematical models. a) Statistical competencies: collect, read, understand, propose a hypothesis, infer, and produce and interpret data to assess the validity and draw conclusions. b) Competencies needed to interpret and act in the social, cultural, political, and economic situations structured by mathematics. **Mathematical Competencies** ● 1st Group Problem-tackling or solving Modeling Reasoning mathematically ● 2nd Group Symbols and formalism **Etic Knowledge** This knowledge refers to constant mathematical phenomena worldwide that do not vary across cultures. Some mathematical techniques, strategies, and concepts are generalizable across cultural groups, and the general idea of mathematical practices is considered a universal phenomenon.	**Technoracy (Material and technological instruments)** Competency to critically use and combine different technological tools and to evaluate their possibilities. **Mathematical Competencies** ● 2nd Group Aids and tools **Dialogical knowledge** This knowledge uses emic and etic knowledge to understand dialogue processes and dynamics of the encounters between cultures. Traditional concepts of emic and etic knowledge are essential points of view for understanding and comprehending cultural influences on indigenous perspectives and mathematical modeling research through the development of technological instruments and resources.
Communicating in, with, and about mathematics a) Understanding others' written, visual, or oral 'texts,' in various linguistic contexts, about matters having mathematical content. b) Expressing oneself, at different levels of theoretical and technical precision, in oral, visual, or written form, about such matters.	**Handling mathematical symbols and formalisms** a) Decoding and interpreting symbolic and formal mathematical language and understanding its relations to natural language. b) Understanding the nature and rules of formal mathematical systems (syntax and semantics). c) Translating from natural language to formal/symbolic language.	**Making use of aids and tools** Information technology (IT) by including: a) Knowing the existence and properties of various tools and aids for mathematical activity and their range and limitations. b) Being able to use such aids and tools reflectively.

Mathematical thinking Mastering mathematical modes of thought, such as: a) Posing questions characteristic of mathematics and knowing the kinds of answers (not necessarily the answers themselves or how to obtain them) that mathematics may offer. b) Understanding and handling the scope and limitations of a given concept. c) Extending the scope of a concept by abstracting some of its properties and generalizing results to larger classes of objects. d) Distinguishing between different kinds of mathematical statements (including conditioned assertions (if-then), quantifier-laden statements, assumptions, definitions, theorems, conjectures, and cases). **Representing mathematical entities** Objects and situations, such as: a) Understanding and utilizing (decoding, interpreting, distinguishing between) different representations of mathematical objects, phenomena, and situations. b) Understanding and utilizing the relations between different representations of the same entity, including knowing about their relative strengths and limitations. c) Choosing and switching between representations.	d) Handling and manipulating statements and expressions containing symbols and formulae. **Reasoning mathematically** a) Following and assessing chains of arguments put forward by others. b) Knowing what a mathematical proof is (not) and how it differs from other kinds of mathematical reasoning, e.g., heuristics. c) Uncovering the basic ideas in each line of argument (especially proof), including distinguishing main lines from details and ideas from technicalities. **Modeling mathematically** Analyzing and building models, such as: a) Analyzing foundations and properties of existing models, including assessing their range and validity. b) Decoding existing models, i.e., translating and interpreting model elements in terms of the 'reality' modeled. c) Performing active modeling in each context. **Posing and solving mathematical problems** a) Identifying, posing, and specifying different mathematical problems, pure or applied, open-ended or closed. b) Solving different mathematical problems, pure or applied, open-ended or closed, whether posed by others or oneself and, if appropriate, in different ways.	