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Exploring Food Insecurity Through Mathematics for Social Justice Lens

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Abstract: This paper explores the intersection of mathematics education, food insecurity, and social justice, focusing on how mathematics can empower students to critically engage with real-world issues. Grounded in Gutstein's (2006) "Reading and Writing the World with Mathematics" framework and UNESCO's Education for Sustainable Development (2020), the study examines how mathematical tasks can foster critical thinking, civic empathy, and social agency. Drawing on data from sources such as the United Nations, the paper highlights the growing global crisis of food insecurity, intensified by conflict, climate change, and inequality. It investigates two central questions: (1) How can mathematical tasks be designed to engage students in analyzing and critiquing food insecurity as a social justice issue? (2) What pedagogical approaches can empower students to use mathematical reasoning to propose solutions to these challenges? The paper presents a structured, phased task that supports both statistical reasoning and critical consciousness, emphasizing localized, and community-based modeling. It concludes by recommending transformative pedagogies that build mathematical competencies and equip learners to act as agents of change in addressing food justice in their communities and beyond.

Keywords: Advocacy, Critical Thinking, Data Analysis, Food Insecurity, Mathematics Education, Social Justice.
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Introduction

In an era where global hunger and food insecurity continue to rise at alarming rates, mathematics education offers powerful tools for understanding and addressing these critical social justice issues. Since 2015, a concerning upward trend in food insecurity has been observed worldwide, exacerbated by the COVID-19 pandemic, ongoing conflicts, climate change, and deepening inequalities (United Nations, 2023). By 2022, approximately 735 million people—9.2% of the world's population—experienced chronic hunger, with an estimated 2.4 billion people facing moderate to severe food insecurity, representing an increase of 391 million people since 2019 (United Nations, 2023). These statistics reflect the urgency of the issue and underscore the need for educational approaches that empower students to engage with real-world challenges through critical and analytical lenses.

Mathematics plays a crucial role in this context, equipping learners with tools to analyze data, identify systemic inequities, and propose meaningful solutions. This perspective aligns with the growing emphasis on culturally relevant pedagogy and mathematics for social justice (Olawale, 2025; ICMI, 2024). By engaging students with real-world issues through mathematical reasoning, educators foster civic empathy and critical consciousness, positioning mathematics as both an academic and transformative discipline.

This study examines the intersection of mathematics education, food insecurity, and social justice through Gutstein's (2006) framework of "Reading and Writing the World with Mathematics" and the principles of Education for Sustainable Development (ESD). These frameworks provide a foundation for designing learning experiences that encourage students to interpret the world critically and take transformative action. In this way, mathematics moves beyond abstract calculation to become a powerful means of social analysis.

The research explores how mathematics education can empower students to critically engage with food insecurity as a social justice issue. Specifically, it addresses: (1) How can mathematical tasks be designed to engage students in analyzing and critiquing food insecurity? and (2) What pedagogical approaches can support students in using mathematical reasoning to propose community-based solutions? These guiding questions reflect a commitment to integrating mathematical knowledge with civic engagement and social awareness.

The paper is structured as follows: Following this introduction, the section Food Insecurity as a Social Justice Issue explores the impact of food insecurity and the systemic inequities that contribute to it. Next, Mathematics for Social Justice and Sustainable Development outlines the theoretical frameworks guiding this study, focusing on Gutstein's approach to critical mathematics education and the principles of Education for Sustainable Development (ESD). The section Pedagogical Approaches in Teaching Mathematics for Social Justice discusses instructional strategies that support the integration of social justice themes into mathematics education. This is followed by a review of Challenges in Teaching Mathematics for Social Justice and an identification of Gaps in Literature. The paper then presents the Proposed Task on Food Insecurity and outlines Goals for Future Research, concluding with key insights and practical recommendations.

By grounding mathematics instruction in real-world data and local community contexts, this study seeks to deepen students' mathematical understanding while fostering critical awareness of systemic inequities. Integrating social justice themes into the mathematics curriculum can enhance engagement, promote evidence-based reasoning, and inspire a sense of agency. Ultimately, the research aims to cultivate socially conscious learners who are equipped to confront and address pressing global challenges through informed, mathematical perspectives.

Food Insecurity as a Social Justice Issue

Food insecurity, defined by Health Canada (2020) as the lack of access to enough nutritious food or the uncertainty of obtaining it in socially acceptable ways, represents a profound social justice issue that reveals systemic inequities within societies. The Food and Agriculture Organization of the United Nations (Retrieved, 2025, March 31) elaborates that food insecurity occurs when individuals do not have consistent access to sufficient, safe, and nutritious food necessary for healthy growth, development, and an active lifestyle.

Recent data illustrates the severity of this crisis. Beyond the 735 million people experiencing chronic hunger, an estimated 2.4 billion people faced moderate to severe food insecurity in 2022—marking an alarming increase of 391 million people compared to 2019 (United Nations, 2023). This global challenge is further intensified by rising food costs, which disproportionately impact low- and middle-income countries, with food price inflation exceeding overall inflation in over half of the countries where data is available (World Bank, 2025).

The understanding of food insecurity as a social justice issue is enhanced by recognizing how equitable access to mathematics education can equip students to analyze complex issues and take informed action (Olawale, 2025; ICMI, 2024). Mathematics classrooms can become spaces for cultivating critical consciousness and civic responsibility, positioning students as informed advocates who can use data and reasoning to challenge injustice. The socioeconomic dimensions of food insecurity are significant and multifaceted. Research by Oduniyi and Tekana (2020) identifies several factors affecting food security status, including household size, age of the household head, and farming experience. Interestingly, they found that female-headed households tend to be more food secure than their male counterparts, challenging common assumptions and underscoring the need for critical analysis of gender dimensions in food security discourse.

Food insecurity's consequences extend far beyond hunger itself. Marmolejo et al. (2024) established a significant link between food insecurity and lower GPAs among college students, demonstrating how inadequate nutrition impacts academic performance. Their research also revealed an inverse relationship between psychological distress and food security, illustrating the interconnection between food access and mental health outcomes. These findings highlight how educational and emotional well-being are closely tied to systemic issues such as food access.

Examining food insecurity through a social justice lens requires understanding its disproportionate impact on marginalized communities. As Mohamed (2023) highlights, analyzing trend data and employing forecasting models can reveal patterns of inequity in food distribution systems. This aligns with Gutiérrez's (2013) assertion that "those who have taken the sociopolitical turn seek not just to better understand mathematics education in all of its social forms but to transform mathematics education in ways that privilege more socially just practices" (p. 40).

The United Nations Sustainable Development Goals framework, particularly SDG 2— “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”—provides a global context for addressing food insecurity. Embedding these global goals into mathematics education not only reinforces the relevance of mathematical concepts but also empowers students to explore critical societal issues, leading to deeper engagement and academic growth (Oduniyi & Tekana, 2020; Saludares & Roble, 2024).

Education for Sustainable Development (ESD) offers a valuable framework for addressing food insecurity in educational contexts. As noted in UNESCO's Education for Sustainable Development: A Roadmap (2020), ESD initiatives can stimulate critical discussions on the connections between different SDGs, sometimes revealing tensions and ambiguities. Through community engagement, learners identify values and issues that concern them both personally and collectively, fostering unity and encouraging collective efforts toward sustainability and social change. As Makramalla et al. (2025) emphasize, mathematics education can empower students to engage critically with real-world challenges, promoting reflexivity and a deeper understanding of the socio-ecological implications of their work. This reinforces mathematics' role not only as a technical discipline but also as a powerful lens for examining and addressing systemic inequities.

In conclusion, food insecurity is a symptom of broader societal injustice with consequences that ripple across academic, psychological, and economic dimensions. Addressing this challenge requires mathematical approaches that empower students to analyze complex data, understand root causes, and propose evidence-based solutions. As Gutstein (2006) suggests students must develop both critical and classical knowledge, building on community knowledge to become effective agents of change in addressing food insecurity.

Mathematics for Social Justice and Sustainable Development

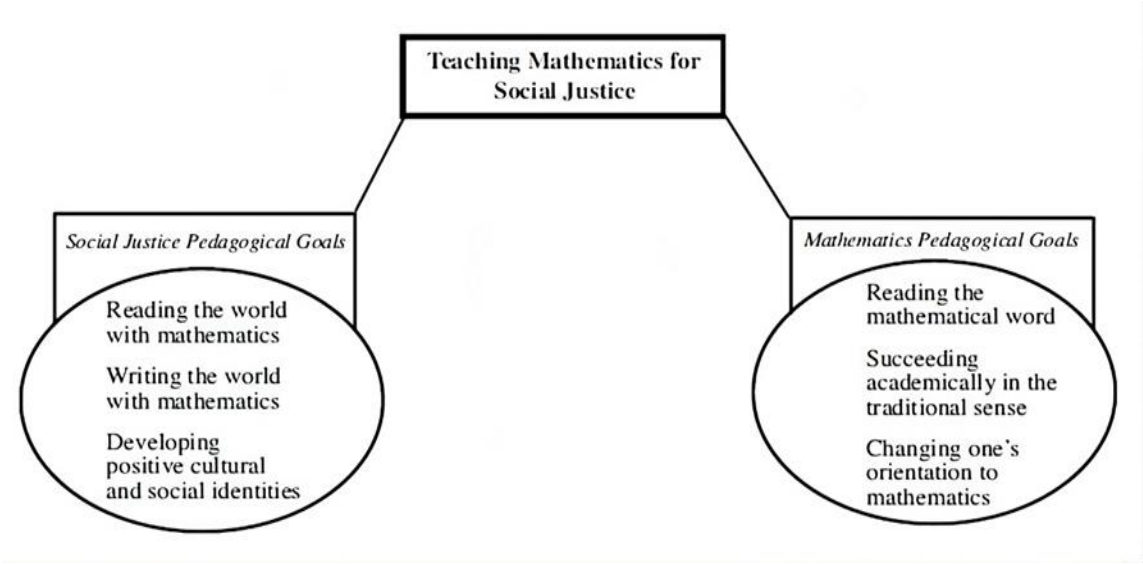
According to Berry et al. (2020), social justice involves recognizing and valuing the diverse contributions of all individuals in society. It emphasizes ensuring fair access to resources, promoting meaningful participation in decision-making, empowering individuals to challenge oppression, and upholding the fundamental rights of every human being. This foundational understanding sets the stage for exploring theoretical frameworks that support social justice and sustainability in mathematics education, including Gutstein's (2006) framework, Education for Sustainable Development (UNESCO, 2020), and Critical Mathematics Education (Skovsmose, 2023).

Building on this foundation, Gutstein's (2006) framework of Reading and Writing the World with Mathematics is rooted in Paulo Freire's critical pedagogy and emphasizes using mathematics as a tool for social justice. He argues that mathematics education should prepare students to critically examine and challenge injustice, stating that they must be able to "investigate and critique injustice, and to challenge, in words and actions, oppressive structures and acts—that is, to 'read and write the world' with mathematics" (Gutstein, 2006, p. 4). To support this goal, Gutstein emphasizes that teachers should recognize and build upon the knowledge that students and their communities already possess. By doing so, students are empowered to apply mathematics to real-world issues, such as food access and distribution, fostering both critical awareness and problem-solving skills (Gutstein, 2006).

Gutstein's (2006) framework emphasizes the dual process of teaching mathematics for social justice through both social justice pedagogical approaches and mathematics pedagogical approaches. This dual process is illustrated in Figure 1 below.

Figure 1

Teaching Mathematics for Social Justice



Note: From Gutstein, 2006, p. 23

Gutstein's social justice pedagogical approaches include reading the world with mathematics and writing the world with mathematics. Reading the world involves using mathematics to critically examine social inequalities, including disparities in income, education, and environmental resources. In contrast, writing the world requires students to apply their mathematical understanding to propose solutions, advocate for change, and engage in community-based initiatives. Gutstein's (2006) framework supports the notion that mathematics education should engage with social justice issues, affirming that effective teaching connects mathematical learning with community experiences and challenges (Saludares & Roble, 2024). Gutstein's (2006) framework underscores the importance of integrating equity and social justice into mathematics education, aligning with findings that highlight the necessity for teachers to provide high-quality educational experiences that reflect diverse student backgrounds (Olawale, 2025).

Similarly, Education for Sustainable Development (ESD) promotes critical reflection and transformative action, which aligns closely with Gutstein's dual-process approach. As ESD is a key component of Agenda 2030, it directly contributes to Sustainable Development Goal 4 (SDG 4), which aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." This goal is fundamental to advancing sustainable development by providing all learners with the knowledge, skills, and values necessary to address global challenges such as inequality, environmental degradation, and social justice (Education for Sustainable Development: A Roadmap, 2020).

Like Gutstein's model, ESD seeks to equip learners with the tools necessary for critical thinking and problem-solving, empowering them to engage in actions that promote sustainability both locally and globally (Education for

Sustainable Development: A Roadmap, 2020). ESD emphasizes the need for tailored strategies that address the specific needs and contexts of learners, much like how Gutstein advocates for connecting mathematical learning to students' lived realities (Education for Sustainable Development: A Roadmap, 2020). By recognizing the significance of context, both frameworks prioritize empowering students to engage with issues they find personally meaningful and relevant.

The principles of sustainability in mathematics education necessitate that curricula are designed to prepare students to navigate social and ecological challenges. Makramalla et al. (2025) emphasize that mathematics not only serves to develop critical thinking skills but also positions students as informed agents of change, linking mathematical understanding to social justice outcomes. In this way, the fusion of Gutstein's framework with ESD provides a powerful foundation for mathematics instruction that is both contextually responsive and socially transformative.

Further strengthening these frameworks, Critical Mathematics Education (CME), as defined by Skovsmose (2023), emphasizes the social, political, and ethical dimensions of mathematics. Skovsmose (2023) argues that mathematics is not merely an abstract discipline but is deeply intertwined with real-world issues and social justice. This perspective aligns with Gutstein's concept of using mathematics to "read the world"—that is, to critically examine societal issues such as income inequality and environmental justice. Similarly, Berry et al. (2020) assert that teaching mathematics for social justice helps build an informed society, connects mathematics to students' cultural and community contexts, empowers students to confront real-world challenges, and fosters an appreciation for mathematics as a tool for social change (p. 23).

However, CME goes a step further by emphasizing the ethical considerations of mathematics as it relates to real-world impact. As Skovsmose (2023) states, "acting with mathematics can have all kinds of social impact and serve all kinds of interests. This calls for deep ethical considerations" (p. 91). This perspective aligns well with the goals of Education for Sustainable Development (ESD), which stresses the importance of ethical reflection and transformative action. Through CME, students are encouraged not only to engage critically with mathematics but also to understand the ethical implications of how mathematics can be applied to address pressing environmental and social issues such as food insecurity, climate change, and sustainable resource use.

The integration of Gutstein's framework (2006) and Education for Sustainable Development (2020) enriches students' mathematical understanding while equipping them with skills to drive meaningful change in their communities. Despite teachers' commitments to social justice mathematics, dominant approaches often persist (Gutstein, 2006), highlighting the need for structured frameworks that support transformative practice. This convergence of theoretical models demonstrates the value of coherence and mutual reinforcement among frameworks that emphasize social justice, sustainability, and critical reflection.

To effectively translate these theoretical frameworks into practice, educators must adopt pedagogical approaches that integrate mathematics with social justice and sustainability. Gutstein (2012) elucidates this process through three essential components: connecting community, critical consciousness, and classical knowledge. These "three Cs" serve as a practical lens for implementing the broader principles of both frameworks. The integration of frameworks like Gutstein's and Education for Sustainable Development principles supports a comprehensive understanding of teaching mathematics from a social justice perspective (ICMI, 2024).

Educators can create an effective learning environment by incorporating students' lived experiences and cultural background, by encouraging students to analyze and question the social and political contexts that affect their lives, and by providing students with the formal mathematical skills necessary for academic and professional success (Gutstein, 2012). As students develop critical thinking and ethical reflections, they become empowered to shape their world through informed, socially responsible actions. The following section will explore practical pedagogical strategies for teaching mathematics for social justice, illustrating how these interconnected principles can be woven into classroom practice.

Pedagogical Approaches in Teaching Mathematics for Social Justice

Community-Based Mathematical Modelling (CBMM)

Gutstein (2012) describes community-based mathematical modeling as an approach that encourages students to use mathematics to address real-life issues within their communities, making learning more relevant and engaging. The adoption of pedagogical techniques that incorporate real-world social justice issues, such as probability and statistics in food insecurity, can lead to meaningful learning experiences for students (Saludares & Roble, 2024). Integrating community contexts into mathematical instruction fosters meaningful connections between abstract concepts and students' lived experiences.

Suh et al. (2023) identify five design principles for CBMM tasks: authentic local community issues, data exploration, critical reflection, civic empathy and perspective-taking, and empowerment through action. Their findings suggest that this approach not only enhances mathematical understanding but also cultivates civic responsibility and social awareness. Emphasizing sustainability in pedagogical approaches enhances students' ability to engage with real-world issues, such as food insecurity. According to Makramalla et al. (2025), integrating reflexive practices within mathematics education fosters critical thinking, enabling students to analyze socio-ecological implications effectively. Smithey and Moldavan (2023) further emphasize the importance of leveraging local resources, such as food banks, to connect mathematics to relevant community challenges. Within this approach, students collect, analyze, and interpret data, thereby developing critical thinking and mathematical competencies.

Gutstein (2006) argues that connecting students' mathematical analyses to social justice issues, rather than using contrived examples, deepens engagement and comprehension. Gutiérrez (2013) also advocates for viewing mathematics as embedded in human experience, suggesting that mathematical thinking should reflect diverse cultural meanings and community knowledge. This approach transforms mathematics education into a vehicle for social change and community empowerment.

Equity-Directed Mathematics

Mathematics is often positioned as a gatekeeper to economic and academic advancement, and ensuring equitable access to mathematical literacy is essential for fostering a just society (Gutstein, 2006). This approach acknowledges that systemic inequities—based on race, class, and other social factors—contribute to disparities in mathematics education (Gutstein, 2012). Embedding equity into mathematics instruction enables educators to challenge dominant narratives that marginalize underrepresented groups.

Berry et al. (2020), citing Picha (2019), outline four foundational approaches to equitable mathematics teaching: Standards-Based Mathematics Instruction (SBMI), Complex Instruction (CI), Culturally Relevant Pedagogy (CRP), and Critical Mathematics Education (CME). These frameworks offer concrete strategies to promote equity through mathematics.

Harper and Kudaisi (2023) illustrate how incorporating themes such as food insecurity enhances conceptual understanding while raising awareness of social injustices. This shift aligns with the sociopolitical turn in mathematics education (Gutiérrez, 2013), which moves away from traditional skills-based instruction toward pedagogies rooted in social justice. Designing emotionally and intellectually engaging tasks encourages students to apply mathematical knowledge beyond the classroom to advocate for systemic change (Kokka, 2022).

Equity-directed mathematics is both an ongoing process and a fixed objective that requires continual reflection (Jong et al., 2023). Educators must facilitate open conversations about racism, poverty, and inequality to empower students as critical thinkers. The socio-critical perspective emphasized by Tidwell and Bennett (2024) reinforces mathematics' role in analyzing and addressing social disparities. A curriculum rooted in such inquiry prepares students to challenge unjust structures and promote social transformation (Voss & Richards, 2016).

Interdisciplinary Approaches

As Yaro and Wagner (2020) note, “Contexts that embrace complexity, interdisciplinarity is unavoidable” (p. 220). Effective social justice-oriented mathematics instruction often involves interdisciplinary strategies. According to the Education for Sustainable Development Goals: Learning Objectives (2017), curricula should integrate sustainability themes across disciplines, including mathematics, science, and social studies. Gutstein (2006) advocates for exploring students' interests through real-world projects that draw on multiple subject areas to deepen understanding.

Gutstein (2012) further suggests that merging mathematics with social studies or science enhances critical thinking and problem-solving, as students apply mathematical reasoning to current global challenges. Research by Garii and Rule (2009) supports this view, encouraging interdisciplinary methods that address diversity and systemic inequality. Similarly, Kozan et al. (2019) highlight STEM education's potential to foster critical consciousness, particularly in relation to food insecurity and environmental justice.

Voss and Richards (2016) provide an example where students used mathematical analysis to investigate world hunger in a global food and mathematics unit. Such interdisciplinary learning experiences demonstrate how mathematics can become a powerful tool for understanding and addressing global problems, promoting both academic rigor and social awareness.

Project-Based Learning (PBL)

Project-based learning (PBL) enables students to engage deeply with real-world sustainability issues, such as food distribution or climate change modeling (Education for Sustainable Development Goals: Learning Objectives, 2017). Gutstein (2006) notes that students find real-world projects more relevant than hypothetical textbook scenarios, making learning more authentic and transformative. Teachers reported that integrating social justice themes into mathematics lessons, such as through Community-Based Mathematical Modelling and Project-Based Learning, not only sparked student interest but also facilitated discussions around real-world issues, which are central to the teaching of Mathematics for Social Justice (Gonzalez, 2024).

PBL requires students to use mathematics to examine complex issues such as racism, inequality, and gentrification (Gutstein, 2012). Smithey and Moldavan (2023) describe how students applying mathematical analysis in projects—such as organizing food drives—develop critical understanding of social challenges. Similarly, Andrews-Larson et al. (2019) support inquiry-based tasks that connect mathematics to students' communities.

Jung and Brand (2021) found that students working on social justice projects gained confidence in critiquing and proposing solutions to systemic issues. Such outcomes reflect the goals of transformative pedagogical models aimed at developing agency. However, Gutstein (2006) cautions that educators must balance social justice content with mathematical rigor to ensure deep conceptual learning. Well-designed PBL experiences thus foster both analytical skills and social engagement.

Collaborative Learning

Collaborative learning enhances mathematical understanding and supports students in applying knowledge to social justice issues. Gutstein (2012) emphasizes that shared problem-solving helps students build mathematical proficiency and a sense of social responsibility. The Mathematics in Context curriculum (Gutstein, 2006) cultivates dispositions such as perseverance, collaboration, and critical thinking—traits essential for analyzing systemic inequities.

Smithey and Moldavan (2023) show how group discussions enhance mathematical reasoning while addressing social issues. The flipped classroom model explored by Lo and Hew (2021) also supports collaborative learning by allowing students to study independently before engaging in problem-solving with peers. Additionally, Lam et al. (2015) found that collaborative learning fosters student engagement across diverse cultural contexts, underscoring the importance of inclusivity.

Collaborative learning not only deepens conceptual understanding but also nurtures empathy and critical thinking. Jong et al. (2023) call for more opportunities and resources to help preservice teachers implement justice-centered math instruction. Similarly, Tidwell and Bennett (2024) advocate for collaborative modeling tasks that address food insecurity and other social challenges. Through such experiences, students become active participants in their communities, equipped to tackle real-world problems through mathematics.

Taken together, these pedagogical approaches form a cohesive framework for designing mathematics tasks that foster both academic and sociopolitical development. In our task (see Figure 1), students analyze data related to food insecurity in their community, interpret statistical patterns, and propose solutions. The task is designed using principles from CBMM, equity-directed pedagogy, and project-based learning, emphasizing critical data analysis, civic empathy, and collaborative inquiry. Through this, students not only develop their mathematical understanding but also engage with issues of sustainability and justice.

Comparative Analysis and Integration of Pedagogical Approaches

Comparative Analysis of Pedagogical Approaches

Although these five pedagogical approaches—Community-Based Mathematical Modelling (CBMM), Equity-Directed Mathematics, Interdisciplinary Approaches, Project-Based Learning (PBL), and Collaborative Learning—are commonly mobilized within social justice–oriented mathematics education, they are distinct frameworks with broader educational significance. Each approach has unique theoretical roots, structural emphases, and instructional applications that extend beyond social justice aims. A clear understanding of their foundational principles, areas of overlap, and distinguishing features is essential for educators seeking to design rich, meaningful, and contextually relevant mathematics learning experiences.

Table 1

Comparative Analysis of Pedagogical Approaches

Pedagogical Approach	Core Focus	Social Justice Link	Core Similarities / Overlapping Features	Key Distinctions
Community-Based Mathematical Modelling (CBMM)	Local, community-based problem-solving	Empowers students to address local social justice issues such as food insecurity.	Shares foundational goals with PBL; both center authentic problem-solving tied to real-life issues	Emphasizes civic empathy, critical data use, and reflective action (Suh et al., 2023, ICMI, 2024)
Project-Based Learning (PBL)	Extended real-world projects	Promotes critical thinking about systemic issues	Aligns closely with CBMM in using extended, authentic problem-solving	Involves long-term project engagement (Gutstein, 2006)
Collaborative Learning	Dismantling systemic inequities in mathematics education	Fosters collective action and social responsibility	Functions as a unifying structure across all approaches	Strengthen mathematical reasoning and cultivate the interpersonal skills necessary for addressing complex societal problems (Jong et al., 2023; Smithey & Moldavan, 2023).
Interdisciplinary Approaches	Integration across disciplines	Connects math with social sciences, health, environment	Integrates seamlessly with CBMM and PBL due to real-world problem orientation	Requires synthesis of knowledge across disciplines (Gutstein, 2012; Kozan et al., 2019).
Equity-Directed Mathematics	Structuring cooperative problem-solving	Aims to challenge inequalities through mathematics	Shares with CBMM and PBL a commitment to social justice	Explicitly challenges the role of mathematics in maintaining or disrupting power structures (Berry et al., 2020; Gutiérrez, 2013)

Taken together, these pedagogical approaches offer a multifaceted framework for addressing the complexities of mathematics education in today's world. Real-world problems—such as those related to sustainability, equity, and civic engagement—are inherently interdisciplinary and require learners to think critically, collaborate meaningfully, and apply mathematical reasoning in authentic contexts. By drawing on the complementary strengths of each

approach, educators can cultivate students' mathematical competencies while simultaneously fostering agency, cultural relevance, and social awareness. This integrated pedagogical lens is vital for preparing students to navigate and contribute to an increasingly interconnected and socially complex world.

Rationale for Integrated Implementation

An integrated pedagogical framework combining all five approaches offers a more comprehensive and responsive model for mathematics instruction, particularly in the context of social justice education:

- **Comprehensive Skill Development:** Integration ensures students develop a full spectrum of competencies—authentic application (CBMM, PBL), critical consciousness (Equity-Directed Mathematics), systems thinking (Interdisciplinary Approaches), and collaborative capacities (Collaborative Learning).
- **Multiple Entry Points for Engagement:** Diverse student backgrounds, interests, and learning preferences are accommodated. Some may connect through community relevance (CBMM), others through interdisciplinary links, or through the relational dynamics of group work.
- **Capacity to Address Real-World Complexity:** Issues such as food insecurity or environmental injustice require a blend of approaches—local focus (CBMM), systemic critique (Equity-Directed Mathematics), cross-disciplinary insight (Interdisciplinary), sustained inquiry (PBL), and collective engagement (Collaborative Learning).
- **Sustainable and Context-Responsive Implementation:** Rather than prescribing a single method, integration allows educators to emphasize different elements based on instructional context, student needs, and available resources, while maintaining coherence around the goal of socially just mathematics education.

This integrated framework thus equips educators with a versatile and powerful toolkit for designing mathematics instruction that advances both mathematical proficiency and critical awareness, preparing students to use mathematics as a tool for social transformation.

Challenges of Teaching Mathematics for Social Justice

Integrating social justice into mathematics education presents several interrelated challenges. Gutstein (2012) highlights the complexity of designing lessons that simultaneously develop mathematical competencies and connect to students' lived experiences and critical consciousness. Standardized curricula often limit opportunities to incorporate relevant social themes, constraining teachers' ability to engage students with meaningful, real-world issues (Skovsmose, 2023). In addition to these curricular limitations, time constraints and potential resistance from parents and administrators can further deter educators from fully embracing social justice approaches (Gonzalez, 2024). Maintaining mathematical rigor while fostering critical thinking about societal issues also requires deliberate and informed pedagogical strategies (Suh et al., 2023).

Time constraints are a particularly significant barrier. Teachers frequently struggle to explore complex social themes in depth due to limited instructional time (Gutstein, 2012). The demands of standardized testing and accountability systems often result in rushed lessons that prioritize coverage over depth, limiting students' opportunities for critical engagement (Gutstein, 2006). Institutional pressures, including the need to align with administrative expectations, further complicate the implementation of social justice content (Voss & Richards, 2016). These challenges collectively hinder the development of robust, equity-oriented mathematics instruction.

Effective integration of social justice also depends on strong teacher preparation. Gutstein (2012) emphasizes the need for educators to possess both content expertise and a deep understanding of students' sociopolitical contexts. Yet many teachers feel underprepared, citing insufficient training and a lack of confidence in addressing sensitive topics (Skovsmose, 2023; Saludares & Roble, 2024). Jong et al. (2023) stress the importance of preservice experiences that merge mathematics with social justice concepts. Suh et al. (2023) further argue that teachers must engage in critical reflection on issues of privilege and oppression to effectively guide discussions on topics such as food insecurity and economic inequality.

Resistance to change also poses a major obstacle. Gutstein (2012) notes that opposition may come from educators, administrators, or broader institutional structures that prioritize traditional mathematics instruction. Many stakeholders perceive social justice approaches as controversial or unnecessary, creating tension around curriculum decisions (Skovsmose, 2023). Teachers often must negotiate with school leaders to justify the inclusion of equity-based content, which can discourage them from pursuing such approaches (Voss & Richards, 2016).

Finally, student engagement presents additional challenges. Some students may be reluctant to discuss politically sensitive issues, while others may not immediately recognize the relevance of mathematics to social justice (Gutstein, 2006; Skovsmose, 2023). These attitudes can affect classroom participation and limit the effectiveness of instruction. To counter these barriers, educators must cultivate inclusive environments that encourage open dialogue and make real-world issues accessible through mathematics. Addressing institutional resistance and curricular constraints remains essential for advancing socially just mathematics education (ICMI, 2024).

Gaps in Literature

Although the literature on teaching mathematics for social justice presents valuable frameworks and pedagogical approaches (e.g., Gutstein, 2006; Gutiérrez, 2013), there is a notable gap regarding their practical application in classroom settings. Specifically, few studies explore how these pedagogies empower student agency or foster meaningful community engagement (Gonzalez, 2024). Skovsmose (2023) emphasizes the need for further research on integrating real-world data—such as food insecurity statistics—into mathematics education, particularly concerning the design of tasks that balance authenticity with mathematical rigor. Suh et al. (2023) similarly

highlight the challenge of aligning social relevance with curriculum standards, underscoring the need for models that maintain both academic integrity and social justice aims.

Teacher preparation also remains underdeveloped in the existing literature. Jong et al. (2023) stress that preservice educators require more structured experiences in planning and delivering lessons that merge mathematics with social justice content. Many educators lack the necessary training, resources, and confidence to address complex social issues like food insecurity through mathematics instruction (Skovsmose, 2023; Saludares & Roble, 2024). This reflects a broader gap in professional development and instructional support. Olawale (2025) further underscores the importance of interdisciplinary research that investigates how community engagement and student agency influence learning outcomes.

While scholars have discussed the potential for mathematics education to foster student empowerment, the specific pedagogical strategies to support this goal are not well defined. Harper and Kudaisi (2023) highlight how students can develop identities as mathematical change agents when engaging with social justice issues, yet practical methods to cultivate this agency are limited. Skovsmose (2023) calls for more research into how critical pedagogy can enable students to investigate systemic causes of issues like food insecurity and pursue justice-oriented solutions. This underscores the need for studies that go beyond theoretical models to examine how such goals are achieved in practice.

Finally, community partnerships are underrepresented in literature. While Skovsmose (2023) advocates for deeper connections between classrooms and communities affected by food insecurity, there is limited empirical research on how mathematics education can facilitate these partnerships. The current gap calls for pedagogical models that promote both critical consciousness and collective action. As ICMI (2024) notes, there is a critical need for interdisciplinary studies and professional support to empower educators in implementing mathematics education that effectively addresses social justice issues such as food insecurity.

Food Insecurity Task: Analyzing Global Food Insecurity Data

Overview and Rationale

This task is designed to engage students in analyzing global food insecurity data as a means of developing mathematical skills while deepening their understanding of social justice issues. By working with real-world data—specifically the Integrated Food Security Phase Classification (IPC), students are encouraged to apply statistical concepts such as measures of central tendency, data representation, and interpretation. The rationale behind this task lies in its dual purpose: to promote critical mathematical thinking and to foster awareness of systemic inequities related to food access. Through this process, students enhance their analytical skills and reflect on the broader socio-political implications of food insecurity and consider potential solutions to this global challenge. Implementing tasks that address food insecurity through mathematical inquiry allows students to apply statistical reasoning and data

analysis to real-world problems, fostering a deeper understanding of both mathematics and social issues (Saludares & Roble, 2024).

Learning Objectives

After completing this task, students will be able to:

- **Mathematical:** Analyze quantitative data, interpret statistical measures, develop spatial reasoning skills.
- **Critical Thinking:** Identify patterns in data, evaluate contributing factors, make evidence-based conclusions.
- **Social Justice:** Recognize systemic inequities, understand root causes, develop informed advocacy approaches.

Task Implementation Framework

The following framework breaks down the food insecurity analysis task into four sequential phases, each designed to develop specific mathematical skills while exploring different dimensions of food insecurity as a social justice issue. Each phase builds upon the previous one, gradually moving students from observation to analysis to action. Teachers can adjust timing based on student engagement and classroom needs, with suggested durations provided. More detailed step-by-step implementations for each phase and students' worksheets can be found in *Appendix A and C.*

Differentiation Options

- **Basic Implementation:** Focus primarily on data analysis with guided discussion questions.
- **Intermediate Implementation:** Add comparative analysis across regions and simple advocacy planning.
- **Advanced Implementation:** Include trend analysis over time and develop comprehensive advocacy campaigns.

The mathematical components embedded within this task directly align with key curriculum standards and competencies in mathematics education. Students engage with statistical concepts such as measures of central tendency — including mean, median, and mode — as they analyze data on food insecurity across different regions. They interpret various data visualizations like bar graphs, pie charts, and scatter plots to identify patterns and disparities. The task also emphasizes proportional reasoning, requiring students to calculate and compare rates and percentages, such as food insecurity prevalence relative to population size. Through these activities, students practice applying quantitative methods that are fundamental to understanding real-world issues, supporting their development of mathematical literacy and critical thinking. By working with authentic data and real-life contexts, students see the relevance of math skills in analyzing societal problems, thus reinforcing the essential role of mathematics in fostering informed, civic-minded citizens. These activities are exemplars of what curriculum standards envision for developing analytical, reasoning, and problem-solving competencies integral to mathematics education.

Table 2

Suggested Task Plan

Phases	Task Element	Mathematical Concepts	Activity	Social Justice Focus	Teachers Support Notes
Introduction	Geographical Analysis	Spatial Reasoning and Data Visualization	Students examine food insecurity maps and identify high/low prevalence regions	Understanding Regional Disparities	Begin with low-stakes observations before moving to analysis
Data Exploration	Population Comparison	Proportional Reasoning and Percentages	Students calculate percentages of affected populations across regions	Recognizing Systemic Inequities	Guide students to look beyond numbers to human implications
Analysis and Discussions	Trend Analysis	Statistical Analysis and Pattern Recognition	Students identify potential factors contributing to observed patterns	Identifying Structural Causes	Use structured discussion prompts to navigate sensitive topics
Advocacy and Discussions	Solution Development	Quantitative Reasoning and Modeling	Students develop data-informed recommendations	Empowering Student Advocacy	Emphasize achievable actions to prevent overwhelming students

Note: This table serves as an instructional roadmap. Each phase intentionally pairs mathematical concepts with social justice perspectives, creating an integrated learning experience. The Teacher Support Notes column provides brief guidance for facilitating each phase - more comprehensive facilitation guides, discussion prompts, and student materials are available in the appendices. Consider your students' prior knowledge and community context when determining which phases may need additional scaffolding or time. A more detailed Teacher's facilitation resources can be found in Appendix B.

Mathematical Competencies and Educational Foundation

Specific Mathematical Competencies Developed

Aligning mathematical competencies with curriculum standards is essential for addressing complex socio-ecological interdependencies tied to social justice (ICMI, 2024). This task cultivates four key competencies that require formal mathematics instruction:

- **Spatial Data Analysis:** Students interpret coordinate systems, map scales, and choropleth visualizations to identify geographic patterns in food insecurity data. Instruction progresses from basic coordinate plane understanding (Grades 7–8) to spatial correlation analysis (Grades 11–12).
- **Proportional and Statistical Reasoning:** Students calculate percentages from large datasets, compare rates across population groups, and evaluate statistical relationships such as correlation, trends over time,

differences between group means, and spatial associations. For instance, they determine that Region A (8.2M/45.3M = 18.1%) has 1.32 times the food insecurity rate of Region B (1.7M/12.4M = 13.7%).

- **Pattern Recognition and Statistical Inference:** Students identify trends, differentiate between correlation and causation, and make evidence-based inferences. More advanced learners compute standard deviations and correlation coefficients to quantify observed relationships.
- **Quantitative Modeling:** Students engage in cost-benefit analysis, resource allocation modeling, and impact forecasting to support data-informed advocacy strategies.

This mathematical task is carefully structured to support students' development of increasingly sophisticated skills aligned with their developmental stages. At the middle school level, students begin by applying proportional reasoning and interpreting basic statistical data, such as calculating percentages and comparing regional rates of food insecurity. As students advance into high school, they engage with more complex analyses, including trend analysis over time and the interpretation of correlation coefficients to understand relationships between variables.

The progression ensures that foundational skills are mastered before tackling more abstract concepts, fostering a scaffolding approach that promotes continuous mathematical growth. By gradually increasing the complexity of tasks, from simple data interpretation to advanced statistical inference—the approach prepares students to handle real-world socio-economic data with confidence and critical insight. This developmental trajectory reflects a well-established educational principle: age-appropriate mathematical reasoning enhanced through scaffolded, meaningful engagement with social justice issues.

Mathematics Education Rationale

This task is grounded in core mathematical thinking processes and belongs firmly within mathematics education. Drawing from Gutstein's (2006) framework for Teaching Mathematics for Social Justice (Figure 1), it addresses both traditional mathematical goals and the cultivation of critical consciousness. Students not only master statistical and proportional reasoning but also use these skills to examine and challenge global inequities.

This dual focus is operationalized through four interconnected dimensions:

- **Mathematical Practices Integration:** Students apply mathematical modeling, statistical analysis, and quantitative argumentation—practices that distinguish mathematical work from descriptive approaches used in social studies.
- **Curriculum Standards Alignment:** The task directly supports standards related to Statistics and Probability, as well as Ratios and Proportional Relationships. Aligning mathematical competencies with social justice contexts enhances students' understanding of mathematics as a tool for societal transformation (Saludares & Roble, 2024).
- **Progressive Mathematical Complexity:** The activity supports learning progression from middle to high school. It begins with proportional reasoning and evolves toward more sophisticated topics such as statistical inference, ensuring age-appropriate mathematical depth.

- **Quantitative Rigor:** Working with large datasets, students practice precision in calculation, reasoning about variability, and creating mathematical models that connect abstract mathematics to real-world contexts.

Through these dimensions, the task ensures both mathematical rigor and social relevance. It exemplifies how mathematics education can meet disciplinary standards while engaging students in critical inquiry about pressing social justice issues. For example, in the Alberta Mathematics Program of Studies, proportional reasoning is emphasized in Grade 8 under "Number" and "Patterns and Relations" while statistical analysis—including measures of central tendency and interpretation of graphs—is introduced by Grade 9 and extended in Math 10-3 and Math 20-2.

This task is designed to foster a range of core mathematical competencies essential for critical engagement with social issues. Students will develop skills in data collection and analysis by gathering local information on food insecurity through surveys or secondary data sources. They will interpret and create graphical representations such as bar graphs, pie charts, or scatter plots to visualize disparities in access and resources.

Additionally, students will apply proportional reasoning and calculate measures such as percentages, rates, or averages to quantify aspects of food insecurity. Crucially, the task promotes mathematical literacy by encouraging students to critically examine data sources for bias and limitations, fostering an awareness of how data can shape narratives about social justice. By engaging in these activities, students not only acquire practical mathematical skills but also learn to interpret and critique complex social data, integrating mathematical reasoning with critical consciousness—an essential aspect of mathematics education aligned with national and international standards. This approach underscores mathematics as a vital tool for understanding and addressing societal challenges.

Implications and Recommendations

Integrating real-world issues into mathematics instruction is vital for fostering both academic and civic competencies. The proposed task analyzing food insecurity data exemplifies how mathematics education can develop critical thinking while remaining aligned with curricular goals. Smithey and Moldavan (2023) highlight the value of authentic data and structured instructional support in enhancing student engagement and accessibility across grade levels. By engaging with IPC datasets, students not only build data analysis skills but also cultivate an awareness of global hunger. This dual focus echoes Gutstein’s (2006) emphasis on mathematics instruction that fosters both classical knowledge and critical consciousness. Kokka (2022) similarly highlights the importance of designing tasks that retain mathematical rigor while promoting emotional and critical engagement with social justice themes.

For mathematics education to become a catalyst for student agency and societal changes, curriculum developers must prioritize tasks that center students as inquirers and advocates. Harper and Kudaisi (2023) advocate embedding

social justice contexts within curricula to enhance relevance and motivation. Suh et al. (2023) support tasks rooted in Community-Based Mathematical Modeling (CBMM), such as analyzing local food prices or mapping access to grocery stores, which effectively bridge mathematical reasoning and real-world advocacy. Makramalla et al. (2025) argue that integrating sustainability themes throughout the curriculum not only strengthens mathematical competencies but also prepares students to address pressing community challenges. These approaches prioritize depth over breadth, encouraging students to critically examine data while envisioning actionable solutions.

Equipping educators to teach mathematics through a social justice lens requires comprehensive professional development and institutional support. Saludares and Roble (2024) and ICMI (2024) stress the need for targeted teacher training that enables educators to inspire critical thinking and engagement. Similarly, Olawale (2025) calls for sustained professional learning that empowers teachers to implement equitable instructional practices. Jong et al. (2023) emphasizes the importance of supporting teachers in navigating complex discussions around inequality and hunger, while Lo and Hew (2021) demonstrate how digital tools can enhance students' ability to visualize and interpret social data. Suh et al. (2023) further argue that teachers must reflect on privilege and structural oppression to facilitate meaningful conversations. Gonzalez (2024) reinforces the need for ongoing support systems to enable effective implementation of Mathematics for Social Justice. As Skovsmose (2023) reminds us, mathematics not only enables quantification but also offers a framework for reimagining social possibilities, making it an essential component of ethical and transformative education.

Goals for Future Research

To strengthen the role of mathematics education in addressing social justice, particularly issues like food insecurity—future research must prioritize classroom-based implementation studies. These studies should investigate the long-term effects of Mathematics for Social Justice approaches on students' mathematical understanding, critical thinking, and awareness of equity issues. Gonzalez (2024) highlights the significance of teacher reflection in gauging student engagement, underscoring the need to examine how tasks shape both mathematical learning and socio-political consciousness. Suh et al. (2023) further identify a critical gap in research concerning the sustained impact of community-based mathematical modeling on students' civic engagement and educational outcomes. Similarly, ICMI (2024) emphasizes the importance of evaluating how mathematics education influences students' perceptions of social justice over time, offering insight into the long-term effectiveness of pedagogical approaches. Longitudinal studies that track these developments will be essential to assess the transformative potential of socially just mathematics instruction.

In addition to longitudinal outcomes, future research should explore how cultural and contextual factors influence student engagement with food justice in mathematics education. Understanding how students' cultural identities shape their perceptions of food insecurity and their willingness to participate in advocacy is vital in designing inclusive and relevant curriculum. Given the global scope of food insecurity and its local manifestations, curriculum

models must be responsive to diverse contexts. Gutiérrez (2013) calls for greater attention to cultural responsiveness in mathematics education, while Jung and Brand (2021) demonstrate that mathematics can reveal intersecting dimensions of justice—such as sustainability, access to nutritious food, and waste reduction. Research should support the development of curriculum frameworks that integrate these interconnected themes to reflect the complexity of real-world challenges. Olawale (2025) adds that interdisciplinary collaboration can enhance the educational impact of socially just mathematics, further emphasizing the need for cross-disciplinary inquiry in curriculum design and evaluation.

Future research should also investigate the systemic and ethical dimensions of integrating social justice into mathematics instruction. Key areas include examining how math education can contribute to broader policy discussions on food insecurity and how educators can ethically address contentious issues like resource distribution and nutritional inequality. Skovsmose (2023) and Tidwell and Bennett (2024) stress the importance of critically engaging with systemic structures through mathematics. Additionally, Saludares and Roble (2024) point to the growing role of digital tools in supporting students' engagement with social issues. Exploring the integration of technology and data visualization can expand students' analytical capacity and deepen their advocacy. Building partnerships across disciplines such as sociology, environmental science, and economics can further enhance both the mathematical rigor and social relevance of food justice education. Through these lines of inquiry, future research can advance mathematics education as a transformative practice—equipping learners to understand, critique, and act upon real-world inequities.

Conclusion

This paper has examined how mathematics education can serve as a transformative force in addressing urgent global challenges, particularly food insecurity. By integrating critical pedagogical frameworks such as Gutstein's (2006) Reading and Writing the World with Mathematics and UNESCO's Education for Sustainable Development (2020), the study has shown that mathematics can extend beyond technical problem-solving to become a powerful medium for ethical reflection, social analysis, and community empowerment.

Through the design and implementation of tasks using real-world data, students are not only equipped with essential mathematical competencies but are also encouraged to cultivate critical consciousness about systemic inequities. Instructional approaches such as Community-Based Mathematical Modeling, Equity-Directed Mathematics, Project-Based Learning, and Interdisciplinary Collaboration foster authentic engagement with local and global issues. These strategies enable students to connect mathematical reasoning to their lived experiences and become advocates for change.

Despite its potential, implementing a socially just mathematics curriculum faces significant challenges. Standardized curricula, inadequate teacher preparation, and institutional resistance remain barriers to transformative practice. Yet,

these challenges also underscore the necessity of reimagining mathematics classrooms as spaces for civic engagement and ethical inquiry.

This article reaffirms the importance of mathematics as a transformative discipline in addressing social justice and sustainability challenges (ICMI, 2024). By positioning mathematics within the context of food justice, educators can nurture learners who are not only mathematically proficient but also committed to equity, sustainability, and collective well-being. When students engage with real-world problems through mathematical lenses, they begin to see themselves as capable of shaping policy, challenging injustice, and contributing meaningfully to their communities. In this way, mathematics education becomes a catalyst for both personal transformation and societal progress.

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Appendix

Appendix A: Task Implementation Guide

[Full step-by-step instructions]

Appendix B: Teachers Facilitation Resources

[Discussion guides, common misconceptions, sensitive topic navigation]

Appendix C: Student Worksheets and Materials

[Warm-up activity, Data collection templates, Guided analysis questions]

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