





Pre-service teachers' perceptions of mathematics education and social justice

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ABSTRACT

Many instances have presented mathematics as a difficult subject for students, and some of these difficulties have been perceived as an injustice to those who suffer from it. Meanwhile, no child is to be left behind in building a just society if all were to experience the collective good of mathematics. For this reason, it became necessary to explore pre-service teachers' perceptions of mathematics as social justice in their lived experiences. In doing this, the qualitative interpretive approach was adopted, where qualitative data was collected, transcribed, and analysed using the case study design. A sample of eleven pre-service teachers were involved in the study. The findings indicated that the pre-service teachers had experienced severe issues of mathematics as social justice in their previous schooling that were unfair to them. However, they now felt mathematics could be interesting if delivered in a manner that let their voices be heard in the delivery process.

Keywords: social justice, experiences, equity, access, power, identity

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INTRODUCTION

Background of Study

Since Ghana's independence, mathematics education and the overall educational system have undergone significant changes and continuous modifications (Adu-Gyamfi et al., 2016; Mereku, 2010; National Council for Curriculum and Assessment [NCCA], 2020). Despite these transformations, mathematics education in Ghana focuses on factual recall and procedural knowledge with a teacher-centred approach (Adu-Gyamfi et al., 2016; Mereku, 2010; NCCA, 2020). Unfortunately, students continue to face challenges resulting from systemic dysfunctions (Adu-Agyem & Osei-Poku, 2012; Falujah, 2015), even though the Education Act of 2008, Act 778, guarantees every child's right to equitable education (Falujah, 2015).

In addition to these challenges, Ghanaian students often perceive mathematics as a difficult subject due to the associated stigma (Langoban, 2020; Mulwa, 2015). Noyes (2007) emphasises the politicised nature of mathematics education and the need to consider whose interests the existing curriculum serves. If left in the hands of politicians, mathematics can become a tool of segregation rather than progress, as it can act as a "gate-keeper" determining students' access to opportunities (Noyes, 2007). However, Baldwin and Squires (2019) offer an optimistic view, suggesting that mathematics can serve as a gateway to political, social justice, and technological development.

Despite this potential, teachers face challenges in reconciling the goals of mathematics education with those of social justice (Bartell, 2013). Hence, students do not perceive and experience mathematics as social justice. To address these challenges and make opportunities accessible to students, teachers must create inclusive classroom environments (NCTM, 2000). This inclusivity should extend to considerations of gender, cultural differences, and, critically, variations in students' abilities. By doing so, students can experience mathematics in a socially justifiable manner and, therefore, perceive mathematics as social justice in their lived experiences!

Furthermore, teachers must explore alternate teaching approaches aligned with NCTM (2000) standards, encompassing reasoning, proof, varied representations, problem-solving, communication, connecting ideas, and problem-posing. By immersing learners in the teaching and learning process, teachers can present mathematical problems that intersect with social justice issues, offering insights into authentic matters of students' interest.

While past studies and legislative acts offer a foundational understanding, it is crucial to highlight their direct impact on persisting injustices in mathematics education. This is because, despite the reforms, notable gaps persist, and resource allocation disparities between urban-endowed and rural-deprived schools persist. Accordingly, Mwakapenda (2002) observed that while education policy formulators engaged with the "need to increase access to and active participation" in mathematics learning, these "efforts have not been

supported by examining the realities of the classroom situation” (p. 278). Furthermore, most primary school teachers lack the potential and competence to teach mathematics, contributing to student disinterest, which remains a significant factor contributing to poor performance in the subject (Chand et al., 2021). Failing to address unaddressed learning gaps could disadvantage learners, thereby being perceived as social injustice. While differentiated instruction is promising, it may still not effectively address all learning gaps in mathematics education (Aguhayon et al., 2023). These gaps impact mathematics education and perception by perpetuating inequalities, hindering student learning outcomes, and shaping pre-service teachers’ perceptions of mathematics as challenging and inaccessible. Despite legislative efforts, these challenges underscore the need for ongoing reforms and targeted interventions to ensure equitable access to quality mathematics education for all as a social justice.

Bond and Chernoff (2015) highlight the potential of mathematics education as a partner in the study of social justice, providing a meaningful context to address abstraction and anxiety. They suggest inquiry-based projects encouraging students to question the status quo, analyse, and draw conclusions from their communities, facilitating meaningful connections among events. The fear is that students may become vulnerable to socio-political and economic oppressors without fostering investigative and problem-posing instincts.

Fletcher (2011) underscores the importance of teaching social justice through diverse, thought-provoking strategies, such as utilising students’ fund of knowledge. A shift from a teacher-centred approach toward collaborative methods that engage creativity is crucial in achieving this goal.

This study explores how basic school pre-service teachers perceive mathematics, its delivery in their former and current levels of studies, and its role as a discipline regarding social justice in their lived experiences. It seeks to determine how students perceive mathematics education through their studies as fair to them. At the same time, Buell and Shulman (2019) identify three forms of mathematics pedagogy—curriculum, methodology, and social education—where the social education aspect is often overlooked. This study highlights the significance of pedagogy as a tool for promoting social justice and focuses on how students perceive it in their lived experiences.

Statement of Problem

Mathematics educators continue to find meaningful ways to deliver mathematics to students since there is replete research that suggests the difficulties that students experience in learning mathematics. For example, Sa’ad et al. (2014) and Suleiman and Hammed (2019) report students’ difficulties as having anxiety and fear, poor teaching methods, negative attitude towards mathematics, overcrowded classrooms, and inadequate teaching-learning materials, while Gafoor and Kurukkan (2015) report similar cases but added that students easily forget what was learned in previous classes, having difficulty understanding the subject and not knowing how to learn as sources of mathematics difficulty. Nolan (2009) argues that students experience such difficulties because there is no social justice even in the classroom, where learners would express their thoughts freely without recourse to the

“teacher as sole authority of transmitting and confirming the correct application of these facts, skills, rules, procedures, it is no wonder that the infallible teacher image inhibits all hope for

student agency and mathematical power, not to mention a teacher’s use of diverse pedagogy” (p. 213).

Notwithstanding this, Gutstein (2003) showed that students who experience autonomy in learning mathematics through social justice and “establish a relationship of trust” with their teachers (Wright, 2017) can demonstrate mathematical power (Gutiérrez, 2009) and exhibit traits of mathematics for social justice. So, if students grow to perceive and experience mathematics in a meaningful way, they will not only see mathematics as

“just a subject they implanted in us just because they felt like it, but now I realise that you could use mathematics to defend your rights and realise the injustices around you ... I mean, now I think mathematics is truly necessary, and I have to admit it, kinda cool. It’s sort of like a pass you could use to try to make the world a better place”. (p. 62).

Coming from this understanding, it is essential to find out how the Ghanaian pre-service teachers experienced and perceive mathematics as social justice in their lived experiences from primary, junior high school (JHS), senior high school (SHS) and college since the ultimate essence of teaching and learning mathematics is to give independence to the learner.

Studies have shown how some in-service teachers give meaning to teaching mathematics as social justice (e.g., Harrison, 2015). Harrison (2015) analyzed the meanings he made to bridge the gap in his conceptual understanding of the social justice of mathematics. In search of meaning for practice, Gutstein (2007) examined the connection between what he termed the forms of knowledge in teaching mathematics for social justice.

Gutstein’s (2003) and Tanko’s (2015) studies involved students who were taught to exhibit the skills of mathematics for social justice using an iterative qualitative approach. The students were found to have demonstrated a substantial amount of social justice through mathematics, while Caswell et al. (2010) worked with pre-service teachers using a qualitative approach.

None has studied pre-service teachers to determine their perceptions of mathematics for social justice and how they perceive and experience it. More importantly, in Ghana, only one study (Fletcher, 2011) was found to have assessed the extent to which social justice theories could be used to explain the inequalities in mathematics education and to explore ways in which such issues would be addressed. Therefore, this study intends to occupy this knowledge gap: to assess pre-service teachers’ perceptions of mathematics for social justice in their lived experiences in Ghanaian classrooms. This is because mathematics for social justice in education aims to provide all children with relevant mathematical knowledge within a societal context.

Purpose of Study

The study aims to explore pre-service teachers’ perceptions of mathematics for social justice as their lived experiences, what they perceive it to be, and how the knowledge of it will change their perceptions and attitudes towards mathematics.

Research Questions

1. How do pre-service teachers perceive mathematics as social justice?

2. What are the lived experiences of pre-service teachers of mathematics as social justice?
3. How has the pre-service teachers' knowledge of mathematics for social justice influenced their perceptions and experiences with mathematics?

LITERATURE REVIEW

Mathematics for social justice in education aims to provide all children with relevant mathematical knowledge within a societal context encompassing equity and critical mathematics, focusing on equitable opportunities and privileges (Xenofontos et al., 2020). Skovsmose and Valero (2005) highlight the importance of teaching and learning practices in opening or closing opportunities for students to access mathematical knowledge and competencies, particularly in equity and social justice. This discussion emphasises integrating social justice principles into mathematics education, focusing on the equitable distribution of socially just practices in teaching mathematics. It centres on justice, which inherently demands equity.

Equity

Teaching mathematics as social justice, as defined by Xenofontos et al. (2020), emphasises equity and critical mathematics. Equity, as they state, involves eliminating predictable disparities in learners' participation and performance based on factors like race, ethnicity, language, gender, sexuality, and social class. Teachers should create an inclusive environment that enables students to construct knowledge independently. Similarly, Gutstein (2003) highlights three aspects of teaching for social justice: fostering socio-political consciousness, nurturing agency, and developing positive social and cultural identities. The aim is to empower students to take ownership of their learning process and outcomes.

Moreover, Gutiérrez (2009) identifies four critical aspects of equity: dominant or critical equity. Dominant equity focuses on access, encompassing student resources for mathematics participation, including teachers' quality and learning materials, affecting opportunities beyond school (Suleiman & Hamed, 2019). Critical equity pertains to achievement, measured through participation in class activities, projects, and exercises, with direct implications for power and economic significance. Denying these opportunities becomes a critical concern.

Critical Mathematics

Equity in mathematics education, as highlighted by Xenofontos et al. (2020), encompasses "critical mathematics," akin to Gutstein's (2003) notion of socio-political consciousness. Critical mathematics involves developing a deep understanding of mathematics to read and write the world, as Gutstein (2006) advocates. "Reading the world" means interpreting mathematics in a social context, such as analysing a business news item, while "writing the world" entails creating meaningful content from what has been understood. Gutiérrez (2009) identifies two critical dimensions within mathematics, one of which is social justice.

First, "identity" involves considering a student's past performance and their relationship with others, referred to as "relational equity" (Boaler, 2008). This emphasises the importance of students supporting one another through collaboration and peer engagement in

mathematics learning. Second, "power" relates to students having a voice in the classroom, the ability to represent themselves, and participate in decision-making. It questions whose voices are heard and valued and whether contributions to mathematical discourse are welcomed without gender, class, or socio-economic biases. True equity in mathematics education is achieved when these aspects are addressed, ensuring that all students, regardless of their abilities, have a meaningful presence in the classroom, promoting mathematics as social justice.

Perceptions

Perception is a social act of mental imprint, which is noticing the actions of others through observation. It helps the individual build an understanding of the thoughts or intentions of others by observing their behaviours (Grezes & Gelder, 2009). Social perception is one's ability to recognise the action(s) of others without them knowing it. Through perception, students have perceived mathematics as challenging to do and that a teacher's attitude could have caused their failure and, therefore, develop either a negative or positive attitude towards the subject or the mathematics teacher (Wasike et al., 2013). Unlike the pre-service teachers in the studies of Karakus and Turkkun (2016), who were asked to identify what they perceived as equality, justice, and social justice, this study seeks to determine the pre-service teachers' perceptions of mathematics as social justice in their lived experiences. That is, expressing what and how they perceived mathematics and mathematics teaching to have been just in their lived experiences.

Empirical Studies

The exploration of mathematics as a tool for social justice in education remains a vibrant area of research. While Panthi et al.'s (2021) studies focused on challenges that preclude students from experiencing mathematics for social justice in Kathmandu's mathematics classrooms, Gutstein's (2003) students experience positive collaboration among students and between parents. This enabled effective technology integration with a deeper understanding of society and inequality through mathematics.

Xenofontos et al. (2020) explored the evolving concept of mathematics for social justice. Their study focused on critical aspects, emphasising that equity should address individual learners' backgrounds and needs. In this context, social justice relates to critical mathematics education and Freire's (1993) concept of *conscientização* through mathematics. Seven practices were proposed to promote relational equity: multidimensionality, role assignment, competence assignment, responsibility for each other's learning, high expectations, effort over ability, and effective learning practices.

Wright (2017) presented a compelling argument based on a study involving five practising mathematics teachers, highlighting that well-planned mathematics for social justice strategies can reduce attainment gaps among students from different social groups. He advocated for systematic inquiry-based research and professional development models to challenge the existing inequities perpetuated by mathematics teaching within society. Wright (2016) reinforced this call through participatory action research with practising mathematics teachers. All this, put together, is believed to enable students to perceive and experience mathematics as social justice.

These studies emphasise integrating mathematics for social justice principles into teacher training and classroom practices. Interactive mathematics lessons for pre-service teachers (Myers, 2019) could help

shape positive perceptions of mathematics as a tool for social justice in their lived experiences.

Theoretical Framework

Freire's (1993) critical pedagogy rejects the traditional 'banking' model, where teachers deposit knowledge into students. Instead, it emphasises a collaborative, inquiry-based approach, where teachers and students think together. This transformative pedagogy positions mathematics as a tool for social justice, allowing students to investigate, scrutinise conjectures, and verify information. Injustice is perceived when mathematics education focuses on procedural knowledge, neglecting collaborative and inquiry-based methods (Wright, 2016).

Building on Freire's (1993) work, Gutstein's (2007) co-creation of knowledge theory views mathematics education as a vehicle to deepen socio-political understanding and self-worth among learners. Continuous teacher-student interaction fosters procedural proficiency. Problem-posing and questioning pedagogy encourages critical thinking in mathematics. In cooperation with students, teachers tap into indigenous and critical knowledge, empowering students to 'read the world' for societal inequities and opportunities. Capital knowledge is essential for seizing opportunities.

The study aligns with Freire's (1993) critical mathematics pedagogy, addressing the limited exposure of pre-service teachers to critical mathematics. It also draws on Gutstein's (2003) theory, emphasising pre-service teachers' critical social knowledge. The goal is to explore how mathematics can serve as a tool for social justice and whether pre-service teachers perceive their own experiences with mathematics as intertwined with social justice.

Conceptual Framework

The framework is well situated in the interconnectedness of the variables, as highlighted by literature, which collectively shape pre-service teachers' perceptions of mathematics as a tool for social justice. These variables include 'access and achievement' on the dominant axis and 'identity and power' on the critical axis, contributing to achieving equity in mathematics education. In turn, the attainment of equity and critical mathematics knowledge influences how pre-service teachers view teaching mathematics as an avenue for social justice. Ultimately, pre-service teachers' experiences with mathematics will impact their perceptions and lived experiences of mathematics as a vehicle for promoting social justice (Figure 1).

METHODOLOGY

Research Paradigm

The philosophy that drives this study was one of qualitative interpretation. Interpretivism is guided by social constructivism, which aims to rely as much as possible on the participants' views of the situation being studied (Creswell, 2014). The interpretivist believes that the nature of reality has multiple perspectives; that is, the interpretivist believes in socially constructed multiple realities (Rehman & Alharthi, 2016). Hence, there is a need to get involved with the study participants and understand these realities through their points of view. To understand the perspectives of the pre-service mathematics teachers on social justice in their lived experiences, understanding must be sought through the negotiated socially constructed meanings produced.

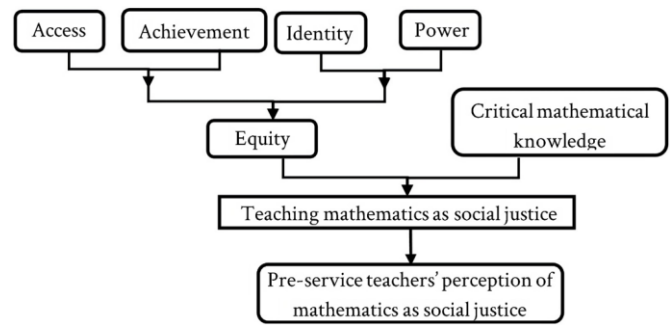


Figure 1. Framework of mathematics as social justice (Source: Authors)

Approach & Design

The qualitative data collection approach was adopted to collect data from participants using the mono-qualitative research within about four weeks. The strategy used here was a case study. The techniques used for data collection were open-ended semi-structured interviews with an inductive data analysis process approach.

Sample & Sampling Techniques

The study sample consisted of eleven pre-service teachers from a college of education in the Eastern Region of Ghana. The sample was comprised of both male and female pre-service teachers. They were basic schools' pre-service teachers in training. They all had primary, JHS and SHS education before enrolling into the college education training as both primary and JHS pre-service teachers. They have all experienced mathematics at these four levels. They will all graduate to teach mathematics at the primary school at one time or another because they are mathematics-focused on that level. They all go for a six-week supported teaching in schools every semester and will go out for an entire semester teaching programme in the fourth year of training. Hence, their perceptions and lived experiences of mathematics for social justice cannot be discounted.

The first criteria for selection were the student-teacher's willingness to participate in the study. The multi-stage purposeful sampling in combination with convenience sampling was used by Omona (2013). Since there were different levels of pre-service teachers available, the multi-stage purposeful sampling was appropriate for every level to be sampled, and it was purposeful as well. Again, the convenience technique was for willing and available pre-service teachers. In this case, sixteen pre-service teachers were scheduled to participate in the study, but only eleven agreed and participated. However, this did not sacrifice quality over quantity (Shetty, n. d).

Data Collection & Analysis Procedures

Qualitative data was collected through interviews using a semi-structured interview questionnaire. The study's objective was explained to the dean of students for permission to involve their students in the research work. Enquiries were made about the year groups available on campus at the time to determine the number of primary education students to select from each level. The purpose of the study was explained to the student-teachers, and those who made themselves available after the selection participated in it. To increase quality over quantity, in-depth interviews were conducted for the data to reach points of saturation and sufficiency, situations, where a further addition of a participant had no meaningful impact on the result (Shaheen et al., 2019). The participants were eleven pre-service teachers with four males and seven females; the males comprised two each from years one

Table 1. Participants responses reproduced according to themes

Main themes	Sub-themes	Samples responses
Mathematics for all: Promoting equity	Equity in access to mathematics education	... mathematics is not an inborn trait ... nobody was born with any subject, so it depends on your interests when you are growing up.
	Inclusion & equity	Because I'm not somebody born with that kind of trait, yes ... I believe mathematics is for men ... men usually understand some of these things.
	Assessment equity:	If there is a different way to assess, it would be very fair to me ...
	Equity in classroom activities	... I engage in those activities ... I receive feedback, if I am wrong, <i>teachers</i> tell me to do correct thing ...
	Feedback & assessment equity	Yes, my assignments are always marked ... Teacher marked exercises but did not provide comments.

Table 2. Participants responses

Main themes	Sub-themes	Samples responses
Empowering students: Fostering agency & voice	Empowerment & agency	I do make contributions a lot; if I understand whatever teacher teaches, ... I do ask questions based on my own volition ... I do not depend on someone ...
	Student voice & agency	... some questions need verbal interactions but because it is specifically based on pen and paper ...
	Student participation & agency	At times, if you answer the question wrong, the teacher makes you look like you do not know anything ... so it is very difficult to raise your hand to answer ...
Equitable mathematics education: Bridging learning gaps	Access to quality mathematics education	I expect teacher to write it on board instead of just saying it thinking that maybe I know.
	Inequities in learning opportunities	Yes ... When I was in primary, my class teacher was a sicklier ... and so he was not attending class very frequently ... JHS too, mathematics teacher was somebody who was very fearful (i.e., being feared by students) ... asking questions and then the canes would start coming on us.
	Perpetuation of inequities	I did not get the opportunity to ... I believe ... it's mostly teacher ... they come to class, but they select a particular group of people that they believe are good & then they pay attention to them so, we are not given ... let me say it is not an inclusive class ...
	Equity in teaching & learning resources	I think that teacher should call me or any of my friends to write whatever <i>we</i> think is right on board, not "do you understand", 'Yes!' then we continue, No!
Transforming education: Advocating for social justice	Social justice advocacy	... not really, but if it's about the dollar ... I care about it. Because you know, that is the money we use outside in buying of items. And comparing our cedis to it, when the dollar goes up then our cedi depreciates so, it goes a long way affecting our lives economically. So, as for this I go and check.
	Stereotypes & bias	I believe mathematics is for a special group of people ... I believe they are born with it.
	Self-efficacy & identity	... and mathematics is something that if you do not practice, you can be perfect.

and three, while the females comprised two and five from years one and three, respectively. Their ages ranged between 21 and 30 years.

The purpose and objective guided choice of using interviews as a means of data collection. Open-ended questions were used to allow for a thorough exploration of the problem. Face-to-face interviews were conducted for convenience and to be able to note non-verbal cues. Participants were chosen based on their willingness to participate, and ethical considerations were followed to ensure confidentiality, anonymity, and respect. The interview questions were developed by reviewing existing literature and expert opinions. The interview protocol was refined through multiple iterations to ensure its robustness (Nowell et al., 2017). Interviews lasted between 28 and 37 minutes. The researcher manually transcribed the recorded interviews to minimise errors. The transcribed interviews were played back to the sign language interpreter to ascertain its correctitude, and so were the others too. The transcribed interviews were then colour-coded to aid analysis. Data was analysed using thematic analysis, where structured coding and code generation were used to meet the requirements of the research questions. In structured coding, passages with terms were used to label questions that were related to them (Belotto, 2018) or vice versa. This was done through prolonged engagement with the data.

Trustworthiness

Trustworthiness issues were handled based on credibility—the extent to which the data set and its analysis are believable or authentic. To ensure this, critical questions were asked to exhaust all possible avenues that sound questionable; ensuring the dependability of the instruments for the data collected, where experts scrutinised and make

sure that they collected the type of data needed to be collected; and confirming the extent to which the findings represented the views of the participants adequately as demonstrated from the data set. Finally, transferability was ensured by making sure that the data collected reached its saturation point, where no one could doubt its trustworthiness and authenticity (Elo & Kyngas, 2008, p. 112; Kivunja & Kuyini, 2017, p. 34).

FINDINGS

Perception of Pre-Service Teachers of Mathematics as Social Justice

Responses to research question one as to pre-service teachers' perceptions about mathematics are captured in **Table 1** and **Table 2**. The responses suggested many critical views of how the pre-service teachers viewed it based on their experiences with the subject and its teachers.

Some of the responses showed that respondents believed that equity in mathematics learning must be for all and therefore there needed to be equity in accessing, inclusion, classroom activities, and giving assessments and receiving feedback to learners. This was demonstrated in such statements by seven of the respondents as "... mathematics is not an inborn trait ..." and therefore everyone was accessible to it.

However, if learners were properly engaged in classroom activities and received feedback as in, "... I engage in class activities ... I receive feedback if I am wrong, and the teachers tell me to do the correct thing

and the method, which I should use in doing that ...” But one is always disadvantaged if the “teacher marks exercises but did not always provide comments. At times when most people did not pass, they brought the questions and explained it better but if he feels the majority has passed, they feel other people can help the others”, “... after everything is done, they just go to the board, correction: they just write everything ... it will be like, just copy it.” Those who perceived mathematics as inherited “believed mathematics is for a special group of people ...” “For my siblings, they are struggling with mathematics ... they are all saying that mathematics is difficult so, I think since ... I’m the only person good in mathematics, then I’m born with it.”

Though some of them saw it as inborn, they believed that one must “learn it so that they will get it”. This was because “like in primary, JHS ... it depends on how the teacher will teach you ... like some teachers, they are not used to that math, so they will not use the correct ways to teach you. So, when you get to the tertiary level and you see mathematics, it will be like it’s a difficult thing for you to study.”

The belief that mathematical success is an inborn trait has far-reaching implications, particularly in the context of education. When this misconception prevails, it reinforces the idea that only certain individuals possess an inherent will for mathematics, while others are destined to struggle. Consequently, this notion can perpetuate a cycle of inequity in the realm of mathematics education, where access to quality instruction becomes unevenly distributed. Students from marginalized groups, who may already face various societal barriers, can find themselves further excluded based on this unfounded belief.

One could address these disparities by encouraging educators to implement intentional measures to enhance students’ involvement in mathematics education. Teachers should strive to establish inclusive learning settings that provide fair opportunities for student engagement. This encompasses a wide range of activities, from traditional class exercises to collaborative assignments and project work. Also, the assessment and feedback mechanisms employed by teachers must prioritize fairness and inclusivity. Assessment practices should be designed to provide constructive feedback, acknowledge students’ unique strengths, and cater to their individual learning needs.

The overarching philosophy of “mathematics for social justice” stands as a powerful counterforce to these inequities. This perspective advocates for one fundamental principle: ensuring that every individual has unfettered access to a high-quality mathematics education regardless of their initial mathematical aptitude. Central to this philosophy is the idea that students’ contributions within the mathematics classroom should be valued unequivocally. In this context, right or wrong answers take a back seat to the value of active participation. Embracing this approach aligns seamlessly with broader principles of social justice, championing inclusivity, fairness, and equity in every facet of the mathematics classroom.

From these responses, it can be observed that the pre-service teachers perceived agency and confidence as means to contribute to mathematics classroom discussions independently, without solely depending on external validation of their answers. It thus, showed that learners should be actively engaged in mathematics classroom activities and that their work should be acknowledged and responded to by their teachers. Again, the responses highlighted the value of learners’ contributions and mathematical power to discuss everyday life issues related to figures, and these issues align with the principles of mathematics education as social justice. After all, learners needed to be

given the opportunities to contribute to classroom activities, express their ideas, and receive feedback that acknowledges and values their perspectives. These promote a sense of ownership, empowerment, and inclusivity in the mathematics classroom and hence, mathematics for social justice.

The pre-service teachers perceived themselves as having been denied access to quality mathematics teaching, equities in teaching time, and learning opportunities. Those who felt denied access to quality mathematics teaching expressed themselves as “I expect the teacher to write it on the board instead of just saying it, thinking that maybe I know,” “... if mathematics were taught in a real live situation, it would have really helped us a lot.” “... if my teacher was patient and then taught the mathematics to our level to understand, I think that would have helped us then too.” Those who felt denied equity in teaching and learning resources were of the view that “Yes ... for the time, he did not use full time. He was the only teacher taking JHS. So, at times it was a combined class, or he teaches partly and moves to the next class.” “We did not have a permanent teacher ... whatever the other teacher teaches is different from whatever the new teacher teaches. The next teacher comes and begins a new topic, saying that when the right teacher comes, he will come and continue...” Those who felt denied learning opportunities said, “Yes ... When I was in primary, my class teacher was a sicklier...and so he was not attending class very frequently ... JHS too, the mathematics teacher was somebody who was very fearful (that is, being feared by students) ... then he will start asking questions and then the canes will start coming on us.” “Those that he thinks that when questions are asked, they answer, he always calls them. In SHS too, the teacher does not come always ... so his period is not always used.” It can be inferred from these that there was the need for equitable mathematics education to bridge learning gaps.

The concept of mathematics as a social justice principle underscores the significance of ensuring that high-quality mathematics education is accessible to every learner, irrespective of their socio-economic background, ethnicity, geographic location, or other potential limiting factors. The responses provided by the pre-service teachers prompted a critical examination of the challenges that can hinder access to quality mathematics education. These challenges included a shortage of qualified teachers, irregular teacher attendance to class, inadequate teaching methods, and limited time and opportunities, contributing to educational disparities among students. These pre-service teachers’ reflections shed light on the existing barriers that hindered their access to quality mathematics education, exacerbating disparities in mathematics learning outcomes and perpetuating social inequalities. Addressing these barriers is crucial to achieving mathematics as social justice and ensuring equal access to quality mathematics education for all students. This highlights the urgent need to identify and address systemic inequities within the Ghanaian education system.

Lived Experiences of Pre-Service Teachers of Mathematics for Social Justice

Research question two sought to find out the experiences pre-service teachers have had to live within the mathematics classroom. In so doing follow-up questions were asked to find out if they had presented answers in class and whether the teacher’s reactions made them feel excluded from the class or not. How they felt when they failed to be successful at a mathematics problem. Or whether their friends pick on them for their failure to work a mathematics problem

successfully. These and other such questions were asked, and the responses were analyzed, as follows:

The responses of the pre-service teachers as captured under inclusive classroom dynamics suggested a situation of not experiencing an inclusive classroom environment “I feel very very worried and lonely because of my situation so if I give an answer and the teacher condemns it in such a manner, I cannot ... I felt I am of no value ... Yes ... I have experienced it before ... at SHS.” “Such students are felt left out in the class, and they isolate themselves, they do not involve themselves in the class”. Some of the experiences of the respondents can be explained as it played out in the power dynamics of the classroom, where “He (the teacher) will tell you directly your answer is wrong and tell you to sit down and then asked for a different person’s work to see if the person’s answer is right”. In some cases, the teachers were reported to be calmer with their reactions as in “When it is wrong, he tells you, try again. The ‘wrong’ comes but the expression tells you that what you have said is wrong, but he does not say it loudly (that is, with distaste)”. Those whose responses could be regarded as an impact on confidence and participation said, “It brings me down totally that maybe anything I say will be wrong so, it is better for me not to even bother myself to answer the question”, “Yea ... at JHS. I felt bad though, but I went to find out from friends”, “I felt very bad. And then it even discouraged me that I’m not sure I’ll be able to know the math”, and “Back then, I feel belittled but now when I’m given the question and I’m not able to answer, I know I can do it so”.

Mathematics as social justice emphasizes the need for inclusive classrooms, where all learners, including pre-service teachers, feel valued, respected, and included. Also, their responses brought attention to power dynamics as it was played out in the classroom, where the teacher was perceived as an authority figure who evaluated learners’ responses as right or wrong. Moreover, the awareness of the potential impact of being told that their answers were wrong on these pre-service teachers’ confidence and participation in the classroom was telling. It was, therefore, important for inclusive assessment practices that recognised the diverse needs and ways of knowing and understanding mathematics. The responses raised the need for reflection on how learners feel excluded or not as part of the class when their answers were considered wrong by the teacher, highlighting the impact of classroom dynamics on learners’ sense of belongingness, experiences, and perceptions of how their answers are evaluated by their teachers.

Again, some of the pre-service teachers’ responses were categorised as ‘stigma’s burden-emotional impact’, where they talked of their experiences as “If there is a question and I am unable to answer it ... and I struggle to solve it, I become bored ... and I think mathematics is boring ...”, “I always feel bad when I go through my result or previous certificates, and I see that I’ve not been able to do well ...”, “Sometimes I do encourage myself so that next time I will proceed and work it out”. So, how do you feel? “Well, I get discouraged because I keep on trying then I get it wrong. It is like mathematics is not meant for me”, “Yes ... at primary ... it was a test ... and they were sharing it ... and they will come to snatch your paper away from you ... they will be looking at it and laughing at you ...” Do your friends label you for failing to work in mathematics successfully? “Yeah, it was ... the teacher ... if he is disgracing us, he disgraced all of us except the girl ... Some friends call you ‘woabon’ (to wit, you are stupid) and all that”.

The responses underscored the emotional toll of learning mathematics, including social stigma, peer pressure, and the

psychological impact of failure on the pre-service teachers, aligning with the recognition in mathematics as a social justice that repeated failures or negative experiences can significantly affect students’ self-esteem, confidence, and motivation to learn, and these emotions are crucial in pre-service teachers’ learning experiences, potentially leading to detrimental effects on their self-perception and facing negative social attitudes and stereotypes from peers that erode self-esteem, motivation, and sense of belonging in the mathematics class.

Some of the responses indicated a form of peer-powered learning within the framework of mathematics as a social justice principle, exemplified by statements like, “I have friends who always support me ... they are willing to assist me whenever I am struggling to solve mathematics questions.” These responses underscored the significance of collaboration and support among pre-service teachers in their mathematics learning journey, where they acted as both recipients and providers of assistance. This highlighted the role of pre-service teachers as peer mentors and the value of collaborative learning. It also resonated with the concept of mathematics as social justice, recognising the pivotal role played by collaborative learning, peer mentoring, and support networks in creating inclusive and equitable mathematics classrooms, fostering positive learning experiences not only for themselves but potentially for others as well.

One of the significances of mathematics for social justice is that it can be used to read the world. That is, the ability to make meaning of the world around oneself, and the responses of these pre-service teachers suggested their strength to do so. When you buy any item that has inscriptions on it, have you ever bothered to read the inscriptions for any reason? “I check the inscriptions and maybe if the date has expired ... I just inform the person that this is not good for use ... so, because of those things it has gingered me, motivated me to read inscriptions on items ...”, “I check out for the dates: the expiry date and the production date, ... I check out the health importance ... the calories in it, the fat and their percentages in it ... If I feel the calories in it will not help me, next time I will not go for it; next time I would go for another one, which will help my health status”.

How Pre-Service Teachers Perceive Mathematics for Social Justice

Research question three sought to find out how respondents’ knowledge of mathematics for social justice influenced their perceptions of mathematics and its teaching. The responses from the pre-service teachers indicated a notable shift in their perception of mathematics, moving from considering it a daunting and difficult subject to one that they found more approachable and even enjoyable, “Previously, it was a scary subject but when I came to college and I got a little basis and understanding, I feel it is not a bad subject at all.” As captured by their statements, this transformation hinted at the potential impact of their evolving understanding of mathematics as a social justice principle on their future teaching approaches and how they were likely to present mathematics to their students.

Emphasis on mathematics in everyday life: “I see mathematics as a way of life ...” “I see mathematics as a good and important course to be taught in school because they helped in our everyday lives ... yes!” “I see mathematics as an everyday something so ... It is not difficult”. “I see it to be a practical life way.” The responses highlighted the relevance of mathematics in everyday life and as a practical life skill. This was indicative of the fact that the pre-service teachers’ knowledge of mathematics as social justice may help to promote an understanding of

the real-world applications of mathematics to their future learners, which may shape the students' future perceptions of the importance and value of mathematics in various contexts.

Recognition of different learning needs, "I realized that mathematics is not as difficult as we thought it was back then in primary school and then in secondary school. I think as you grow... your brain also grows and therefore you begin to understand a lot of things. At the college level, the teaching approach has also changed ..." "I know mathematics depends on the method in which the teacher uses to teach, so the methods determine if you understand it or not, and that is what I have realized so far." It can be noticed from these responses that teaching methods and approaches used by teachers can impact learners' understanding of mathematics. This suggested that the pre-service teachers' knowledge of mathematics as social justice may sensitize them to determine the learning needs of students and diverse important inclusive pedagogical practices, which may influence their future perceptions of mathematics as a subject and their approach to teaching mathematics.

Recognition of teachers as authorities, "I see him to be great though in class ... but I do not see him as he is able to answer any (all) question because I had an experience, where a question was given to our teacher and then, the answer he brought was a wrong answer, so I know he can also make a mistake." "I see the mathematics teacher as someone who knows the subject, mathematics ..." "I see the mathematics teacher that he knows everything... whatever he says is correct and it is final". "I see the mathematics teacher as the boss in the class. I see him as the creator of knowledge". The views of the respondents reflected a perception of mathematics teachers as knowledgeable and authoritative figures who hold the answers and confirm right or wrong answers. This suggested that the pre-service teachers' knowledge of mathematics as social justice may impact their view of mathematics teachers as experts in the subject matter. This perception could defeat the idea of mathematics for social justice since they may indulge in acts of authoritativeness that may not allow learners to exhibit their knowledge and skills thereby stifling the potential of learners in the mathematics classroom.

DISCUSSION

Mathematics is a crucial subject that all learners, including pre-service teachers, must deal with in order to succeed. Therefore, pre-service teachers must tackle mathematics at both JHS and SHS levels before encountering it again in college. However, due to misconceptions and perceptions about the subject, many students are afraid of it and find it difficult to overcome, leading to its reputation as an unfair subject. The research aimed to investigate how pre-service teachers perceive mathematics as a socially just subject in their own experiences. The data collected suggested that the pre-service teachers held perceptions that aligned with the idea of mathematics being a tool for social justice, which they had encountered in their previous learning before college.

The perceptions the pre-service teachers held about mathematics determined how they responded to its issues as according to Grezes and Gelder (2009). The findings suggested that some of the pre-service teachers perceived themselves as incapable of learning and understanding mathematics when they were at both JHS and SHS. However, when they managed to get to college, they could realise their potential and now perceived themselves as being capable and enjoying

mathematics. Perception holds one back from achieving one's dreams. Some of them still held negative perceptions (Wasike et al., 2013) about themselves and that being good at mathematics was inborn. The adherence to this perception could deny their future students the opportunity to enjoy mathematics as a social justice. Thus, pre-service teachers who still perceived themselves as being "dyscalculia" due to inherent traits would negatively influence and perpetuate this perception to the disadvantage of their future students. However, those who had experienced mathematics in a positive way from college were more likely to perceive it in a positive light not because it was inherent but because one can improve upon it thereby instilling the same in their future students. While the research participants of Karakus and Turkan (2016) were asked to identify what they perceived as mathematics as social justice, the participants in the current study were asked to tell their experiences of mathematics as social justice. During their earlier schooling, the majority of the pre-service teachers perceived mathematics as scary and difficult. Having experienced mathematics at the college level, most of them now claimed they now saw "mathematics to be one of the best subjects that me, I really have interest in it". In another breadth, all of them except one saw the mathematics teacher as the only one who could determine if their answers were wrong or not. This position is not recognised in mathematics as a social justice since it reduces the learner to a dependant (Gutiérrez, 2009) on solely external validation of right or wrong answers. The fear is that such students cannot exploit their potential since they may always be expecting needless support from the teacher. A situation Gutiérrez (2002) referred to as using the power of mathematics. This was to encourage students to develop their mathematical identities, voice their ideas, and actively participate in the classroom activities of learning mathematics.

The results of the findings of the experiences of the pre-service teachers aligned with Nolan's (2009) argument that there was no social justice even in the classroom, where learners will naturally have the freedom to express themselves. The findings showed how pre-service teachers expressed their mean situations in the classroom when they had worked and produced wrong answers. If students cannot expressively demonstrate their knowledge or understanding of a mathematical concept in the classroom, where else could that be? This situation bothers on the principles of social justice in mathematics teaching in the classroom that promotes students' voice agency and participation in class activities.

The results of the study also align with the findings of Sa'ad et al. (2014) and Suleiman and Hamed (2019), which found that pre-service teachers identified factors that entrenched their perception of mathematics as difficult. Some of the respondents reported having had no mathematics teachers in their earlier schooling at certain points in time, having part-time mathematics teachers who taught varied topics all at different times without integrating the flow of ideas in the lessons, absentee teachers (some due to intermittent ill health), large classes, issues of assessment and reporting to students. While Panthi et al. (2021) reported absenteeism of students in their study, it was teachers who were reported absent in this study. These were matters of concern as far as mathematics for social justice principles were to be addressed. In the absence of an indisposed teacher, a substitute, competent, reliable, and regular mathematics teacher needed to be sought so as not to disorganise the students' learning.

Equally important was how some of the assessments of the pre-service teachers were done during their previous studies. The findings showed that students' work was assessed without commenting. As one respondent rightly said, marking to be correct was not enough but explaining the 'how' and 'why' were very important. This tends to make assessment incomplete.

Mathematics achievements are, therefore, not merely about having good grades but how meaningful the grade is. It cannot be established in mathematics as social justice if equitable opportunities for engagement (Gutiérrez, 2009) are not given to the learners to express themselves in exercises, assignments, and project work. Moreso, this prompts the issues of teacher responsiveness in marking and commenting on learners' work. Access to quality mathematics teaching is found not only in the presence of teaching and learning resources or the mere presence of a qualified mathematics teacher but also in how purposefully useful these are. The findings indicated that most of the pre-service teachers were lacking in quality and equity utilisation of quality teaching and quality teaching time, and inadequate teaching methods were insufficiently supportive of the respondents' learning, thereby denying them quality teaching, which was in tune with the findings of Chand et al. (2021).

Mathematics as social justice emphasises the need for identity. Identity is found in the collaborative support of one student to the other in their learning process. The findings indicated what Boaler (2008) called 'relational equity', that most of these participants were helpful to one another during their earlier schooling at JHS and SHS in doing mathematics. By this, mathematics as social justice supports networkings that play a crucial role in fostering inclusive and equitable classroom learning. In addition, the findings showed that some pre-service teachers peer-mentored their colleagues even after regular school engagement.

One of the significance of mathematics as social justice is for the individual to be able to use mathematics to read the world. The findings were in line with Gutstein's (2006) critical mathematics that assisted his participants in reading the world around them. Reading the world means deliberately reading and making meanings out of all mathematical figures or expressions that affect one's life such as on labels of food containers, economic reports from the media, and the rest. The findings indicated that some of the pre-service teachers were cautious about reading the world around them, particularly what they consume, while most others hardly took any importance in it. It must be noted that reading the world through mathematics is liberating oneself from harm—contending with the expiry dates of consumables, for instance.

CONCLUSIONS

In conclusion, the study on pre-service teachers' perceptions of mathematics as socially just in their lived experiences revealed that the perceptions they held about mathematics greatly influenced their responses to the subject. While some pre-service teachers had negative perceptions of mathematics as difficult or something that they were inherently incapable of understanding, others who had positive experiences in college now saw mathematics as enjoyable and a subject they were capable of excelling in. However, there were concerns about the lack of student agency, teacher responsiveness, and equitable opportunities for engagement in mathematics classrooms, which are

important aspects of mathematics as social justice. Factors such as absentee teachers, large classes, and inadequate teaching methods were identified as barriers to quality mathematics teaching. The study emphasizes the need for collaborative support among students, teacher responsiveness in marking and commenting on learners' work, and purposeful utilization of teaching and learning resources to promote equity and social justice in mathematics education. Overall, the findings highlight the importance of addressing perceptions, promoting student agency, and ensuring quality teaching practices to create a socially just mathematics learning environment for all learners, including pre-service teachers.

Implications

The study highlights that pre-service teachers' perceptions of mathematics play a significant role in their experiences. Negative perceptions such as believing that being good at mathematics is inherent or that mathematics is difficult, can hinder students' learning of the subject. The study showed that the actions of some teachers could lead some students to feel dependent on the mathematics teacher for validation of their answers, which can limit their ability to express their ideas and actively participate in classroom activities. It is important to address and challenge these negative perceptions, both in pre-service teacher education programmes and in classroom settings, to promote a positive and inclusive learning environment for all students by rethinking the meaning of mathematics achievement; addressing factors that contribute to negative perceptions of mathematics itself and fostering collaborative support and identity development among the pre-service teachers.

Recommendations

Based on the findings of the study, it is recommended that pre-service teachers be provided with opportunities to reflect on their perceptions of mathematics as a social justice issue. This could be done through lectures or seminars that focus on promoting a positive growth mindset among pre-service teachers. Also, using collaborative learning, problem-solving activities, and open-ended tasks that allow students to express themselves, pre-service teachers can be encouraged to create a positive classroom environment. Efforts should be made to ensure that pre-service teachers have access to quality teaching resources, teaching methods, and teaching time that is supportive of their learning that will promote effective teaching strategies, and address such issues as absenteeism among teachers. Finally, it is recommended that pre-service teachers are encouraged to develop their own mathematical identities and recognize the importance of collaborative support among students in the learning process.

Further Studies

Since these pre-service teachers have the opportunity to do macro teaching before completion and an additional year as interns, a study on the impact of their perceptions of mathematics on their future students' attitudes toward mathematics could be investigated. Therefore, such a study could investigate how pre-service teachers perceive mathematics as socially just or unjust and how it affects their teaching practices and their students' attitudes toward mathematics. It could also explore how pre-service teachers' beliefs about their own mathematical abilities and the inherent nature of mathematics influence their instructional strategies and interactions with learners, and how these perceptions may perpetuate, or challenge social injustices related to classroom mathematics learning.

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