Math for Innovation: Empowering Tanzanians for Self-Employment through Numbers

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Abstract: *How does integrating math skills improve self-employment creation? This study combines Systematic Literature Review (SLR), bibliometric, and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to find the answer. By analysing 51 key articles, the research pinpoints two main factors: math proficiency, and applied approaches. The review further emphasizes the benefits of using math for innovation adoption across various self-employment performance metrics in Tanzania, including market need analysis, financial, and investment decision performance. The novelty of this article lies in its comprehensive integration of PRISMA and bibliometrics analysis to explore how math becomes foundational to self-employment in Tanzania and bridge gaps in existing literature. Results show that publications relating to math for innovation and self-employment were cumulative increasing from 2000 to 2025 Mtebe found as the most prominent author. Additionally, Singapore, China and other OECD countries led in both math proficiency and innovation. Ultimately, this study argues that fostering a math-literate community is not only essential for individual success but also for national economic growth, as it nurtures a culture of innovation and well-versed decision-making.*

Keywords: Innovation, Self-employment, Artificial Intelligence, Math Anxiety, Mathematics Proficiency.

JEL classification: I25, I26, 031

1.0 Introduction

Mathematics is not just a subject taught in schools and universities; it's a life skill that shapes how individuals think (neural architecture change), solve existing problems (weather risks, food security, energy etc) and make optimal decisions (Salmani Pour Avval, Eskue, Groves, & Yaghoubi, 2025; Vasin, Davidson, & Novikova, 2024). Yet to many primary and lower secondary school students, math remains a source of anxiety and disengagement as reported by recent scholars (Zhu, Liu, Xiao, & Sindakis, 2024). This research aimed to understand the role of mathematics on innovation, thereby empowering Tanzanians for self-employment. This will make the Tanzanians to get

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interested in math thereby developing the potential skills in innovating new technology and self-employments for overcoming cotemporally unemployment challenges.

2.0 Theoretical Review

Mathematics is a foundational subject with broad applications in real life experience, from budgeting, engineering, health and agriculture to entrepreneurship and technology. However, in many Tanzania students (form both primary and lower secondary), mathematics is often perceived as tough, irrelevant, or intimidating and leading to low confidence, poor performance and disinterest among students (Kikomelo, Gowele, & Mofi, 2024). This trend is especially pronounced in regions with limited trained and talent math teachers (those who are not good skilled in arousing the interest to math learners and able to link math theories with real-world experience), access to quality educational resources, and extracurricular support (mathematical games and sports) (Kissima, Lema, & Mwakalinga, 2024).

Globally, recent assessments from Australia and New Zealand, the researchers reported that issues such as critical thinking, declining performance and reasoning and problem solving in mathematics, two countries have drawn renewed attention to the importance of early childhood education and the need for relevant research-based assessments of young children's mathematical thinking that can intersect and align with the early years of school (Stephens et al., 2024). To improve educational quality including math in the existing era, international organisations such World Bank, Organisation for Economic Co-operation and Development (OECD), and UNESCO have shaped the educational policies by highlighting their values and modus operandi. In line with results-oriented educational management, all teachers are perceived as essential resources for promoting student performance and are pressured through mechanisms that combine evaluation, accountability, and dissemination of best practices (Souza, 2024). Cotič, Doz, Jenko, and Žakelj (2024) in their mathematics education research question "*what was it, what is it and what will be*" explored the answer by integrating shift trends for emphasizing mathematics literacy. The transformative integration achieved by incorporating virtual reality (VR) which responsible for comprehension of abstract concepts (math demystification) and artificial intelligence (AI) that offers personalized learning experiences that found to emphasize practical, contextually relevant approaches.

In Tanzania, the Basic Education Statistics in Tanzania (BEST) unveiled that mathematics remains one of the lowest-performing subjects in both primary and secondary education, with national average pass rates frequently falling below 50% (UNICEF, 2017). This trend is even more pronounced in rural areas, where limited resources, large class sizes, and a shortage of skilled and talent math teachers create barriers to effective teaching and learning. Findings from the Uwezo Tanzania Learning Assessment Report

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(2020) confirmed that a large proportion of Standard 3 to 7 pupils are unable to perform basic arithmetic operations such as addition, subtraction, and multiplication appropriate for their grade level (Uwezo, 2020). The report further pinpoints disparities in performance based on gender and location, with girls and children in remote communities often lagging behind their urban counterparts.

Another key issue is the lack of parent-student engagement and positive attitudes toward mathematics (Essumang, 2022). Many students grow up perceiving math as difficult and intimidating or irrelevant, often due to rote teaching methods and a lack of practical, math efficacy and real-life applications (Katera & Msafiri, 2020). This perception contributes to low self-confidence and a lessened interest in pursuing STEM careers. There is therefore a pressing need for innovative, inclusive, and community-based interventions to promote mathematics education in Tanzania. This study proposes a grassroots review approach to make mathematics more accessible, interactive, and inspiring through demystification. By working with primary and lower secondary students, teachers, parents/guardians, and the related stakeholders, the initiative aims to transform mindsets, strengthen foundational math skills, and support long-term upgrading in math learning outcomes. In light of increasing awareness of integration of math on innovation for empowering Tanzanians toward self-employment, the author develops clear questions to ensure that review understudy remains focused on the topic explored. This review research aims to answer various questions, including:
RQ 1: How math anxiety drives math proficiency?
RQ 2: How artificial intelligence drives math proficiency?
RQ 3: What are applied approaches and empowerment strategies in enhancing self-employment in Tanzania?

3.0 Methodology

This review research employed a systematic qualitative review approach aimed at synthesizing existing literatures, policy documents, educational frameworks, and case studies related to the role of mathematics in enhancing innovation and self-employment, with a specific focus on the Tanzanian context. The method bridges the gaps from existing literatures as suggested by Gikandi, Morrow, and Davis (2011). Initially, the author of this study used commonly database of this field this not limited to (e.g., Google Scholar, Scopus, Web of Science, Springer, sage, Science Direct and jstor).

3.1. Research Design

The searching used the term 'Math for Innovation: Empowering Tanzanians for Self-Employment through Numbers' for the articles published between 2000 and 2025 as initial search year since Tanzania's strategic development framework from 2000 to 2025 that guided by the National Development Vision 2025 (Dira ya Maendeleo ya Taifa 2025

outlined the country's long-term aspirations to transform into a middle-income, semi-industrialized nation by the year 2025, MKUKUTA I & II: National Strategy for Growth and Reduction of Poverty (2005–2010 and 2010–2015) and Education and Training Policy in which the author intended to explore the degree of success attained thereby suggesting the optimal plans for new vision of 2025-2050. The author modified the search to suits the context of this study such as 'approaches towards math innovation or strategies for improving creation of new self-employments. The literature searching was limited to journal articles, book chapters, books and others early access articles while excluding thesis and dissertations, editorials, conference review, comments, and other non-official documents were strictly omitted. A total of 112 (*see* Table 1) articles were obtained and sorted regarding the research question mentioned in section one. It should be noted those research papers which did not reflect the themes of this study and failed to verify feasible solution were excluded from this research work. The following table shows the features of the selected studies based on the geographical location. From the total of 112 articles selected, the study chosen only 47 (*see* Table 2) articles using systematic literature review as applied by Bond et al. (2024) the methodological guideline for article review. The methods specified inclusion criteria.

3.1.1. PRISMA Approach

This study seeks to provide a full overview of how the integration of math in innovation is used in empowering Tanzanians toward improving self-employment creation settings and how it affects economic growth performance. The study employs an SLR to identify critical ideas, obstacles, and opportunities related to innovation adoption. By evaluating pertinent material, the review intends to offer insights into existing practices and trends in math integration for innovation adoption within economic activities.

3.1.1.1. Inclusion and Exclusion Criteria

In the setting of this review's analysis, the assessed inclusion and exclusion criteria which will be analysed essential to be identified. To make the study robust, articles were selected depending on the specific research questions, and the papers selected found in both Tanzania and other countries. Every paper has to meet the needed specific criteria in order to be involved. The publishing year between 2000 and 2025 and the original language of the articles published in English and Greek were updated. Articles need to encompass the role math in critical thinking and innovation and self-employment Another very important inclusion criterion appeared to be articles that explore the relevance of promotion of self-employment. Papers that had lack of relevant information for the research method they followed, along with their collected sample, were also excluded as presented in Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Concluding, articles were excluded due to their less information beyond the need. In summary, all inclusion and exclusion conditions of the article are presented in Table 1.

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Table 1: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
Peer-reviewed journal and quality math for innovation and self-employment articles	Blogs, Editorials, and Opinion pieces
Papers published in English	Non-English published articles without translation
Article focused on math for innovation and self-employment articles	Studies unrelated to math for innovation and self-employment articles
Articles with relevance to promotion of self-employment through mathematics integration	Articles without showing the relevance of self-employment through mathematics integration

Initially 132 articles were identified on the electronic databases such as google scholar, web of science, Scopus, and SAGE. After reviewing the study titles and their quality, nine (n = 19) papers were found to be matching (duplicate) and therefore were removed, with the majority of the articles to refer either to publication in conference or graduate/doctoral thesis. After removing unrequired papers, the total number reached 113. From those papers fifteen (n = 18) were rejected, as failed to respond the study questions of this review. From the total papers (n = 95), a selected amount of them (n = 44) found to be far from relating any of the inclusion criteria. Overall, only fifty-one (n=51) papers met all the criteria and therefore were included in this study.

3.1.1.2. Data Extraction

The following collected data was extracted from the included articles: author's name, year of publication, rank of publication venues, and co-authorship interaction country as exhibited in the flowchart shown in Figure 1.

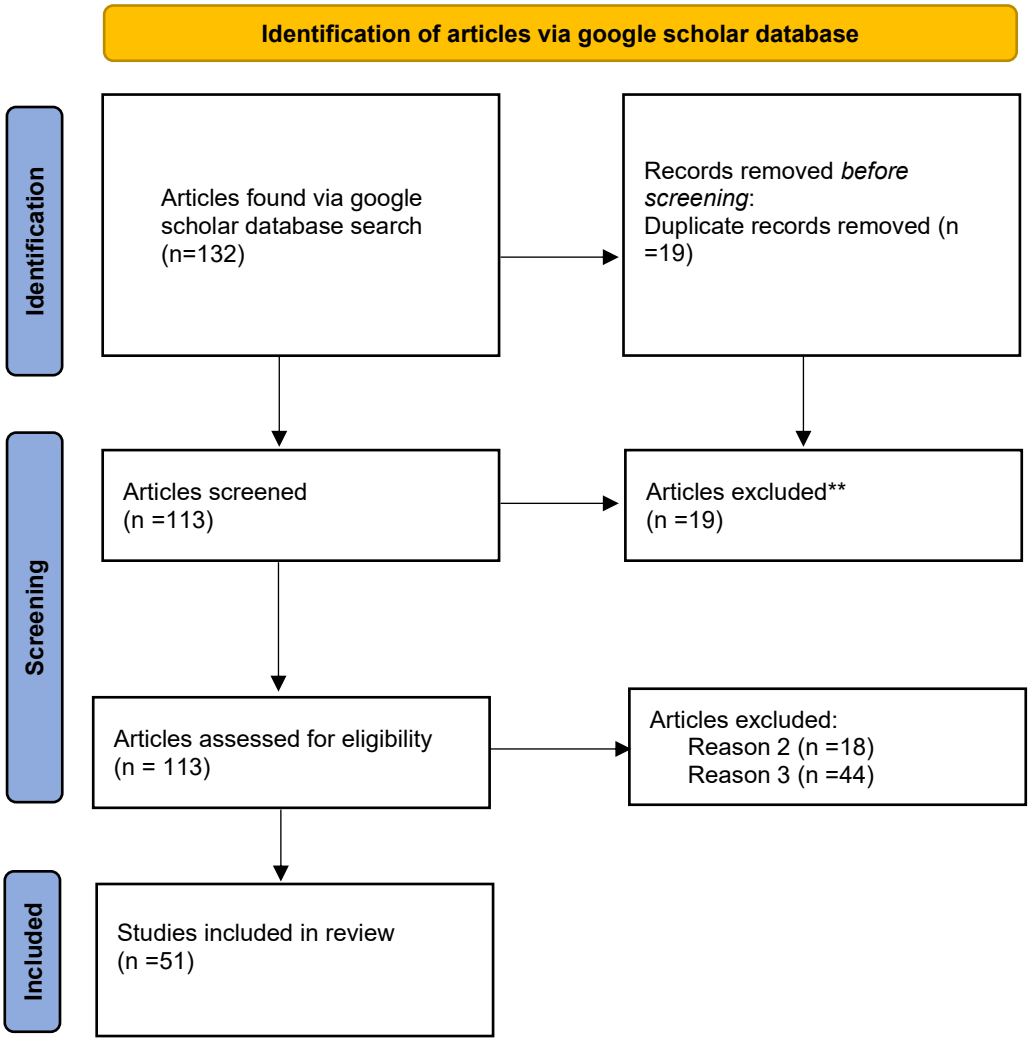

Figure 1. Flowchart demonstrating the process of math for innovation publication collection, reviewed using PRISMA.
Source: Source: Page MJ, et al. BMJ 2021;372: n71. Doi: 10.1136/bmj. n71.

3.1.2. Bibliometrics Approach

The bibliometric approach is used in this study. VOS viewer, Bibliometrix (Bibliometrix R Package) version 4.1.0, and Publish or Perish version 8.0 are the simulation software employed in this research. The Publish or Perish is used to evaluate publications on math integration in innovation. In the meantime, data from academic publications, bibliographic databases, and information from other sources are analysed using VOS viewer by displaying connections between publications, authors, citations, and particular research fields, bibliometrics enables the understanding and visualization of bibliographic information. The bibliometrics function is vital to help decision-making in academic presentation assessment, research development, and strategic planning. The author searched the academic database because Google scholar is viewed as one of the biggest sources of a wide variety of peer-reviewed journal articles (Chhatoi, Sahoo, & Nayak, 2021). The bibliometrics analysis encompassed papers published between 2000

and 2025, or within the last 25 years. The following guidelines were carried out using RStudio and Google scholar: 1. Select the search terms. This instance relates to "Math for Innovation". Used the research title, abstract, and keywords TITLE-ABS-KEY ("Math AND Innovation") to search Google scholar for the term "Math for Innovation". Adjusted search findings by using filters. (LIMIT-TO (OA, "all")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (LANGUAGE, "English")) TITLE-ABS-KEY ("Math for Innovation and Self-Employment in Tanzania") Saved the search results as a file with the bib extension (e.g., language used, year of publication, type of publication and population), literature identification, screening for inclusion, quality and eligibility assessment and repetitions.

4.0 Results and Discussion

The following sections present the findings of this study obtained from intensive reviewed of 51 studies as per case study. The outcome has divided into two main sections including the foundations of mathematics for innovation and self-employment followed with applied approaches and empowerment strategies and lastly conclusions and recommendations for further expansions of how math triggers innovation thereby enhancing creation of self-employments in Tanzania.

Table 1: Prominent authors by publication count

Rank	Author	Total Publications	Total Citations	First Publication	Last Publication	Active Years	Prominence Score
1	Mtebe	2	2	2020	2024	5	2
2	Abdel-Badeeh M;	1	1	2020	2020	1	1
3	Aimee; Showalter	1	1	2011	2011	1	1
4	Ali; Bicer	1	1	2023	2023	1	1
5	Ally; Pothin	1	1	2020	2020	1	1
6	Alvareze; Michael	1	1	2022	2022	1	1
7	Anderssen	1	1	2016	2016	1	1
8	Andrew; Glanfield	1	1	2019	2019	1	1
9	Angel;	1	1	2010	2010	1	1
10	Anna;	1	1	2021	2021	1	1
11	Arthur	1	1	2018	2018	1	1
12	Ato Kwamina;	1	1	2018	2018	1	1
13	Augustino; Simba	1	1	2025	2025	1	1
14	Ayoub; Fisser	1	1	2015	2015	1	1
15	Aysenur; Capraro	1	1	2023	2023	1	1

Table 1 and Figure 2 show the list of top 15 authors that highlights writers with at least one citation, publication and prominence score on the study of math for innovation within the period from 2000 to 2025. The results demonstrates that Mtebe leads this list,

demonstrating 2 province score, publications and citations. Figure 3 with two plots (histogram and cumulative curve) unveil the data that illustrates a clear and consistent inclination in the yearly number of articles published over time. Histogram plot shows the low rate of publications in the early period of 2000 while the cumulative curve demonstrates a gradual increase that substantially increases in more recent years. This growth pattern in publication reflects the global reach in scientific publishing, and research output likely driven by influences such as increased research need of self-employment optimization in the global research community, and the rise of open-access publishing settings which have made distributing findings easier and faster. The steepening slope of the curve emphasizes that the pace of math and innovation publication is not only growing but is doing so at a cumulative rate.

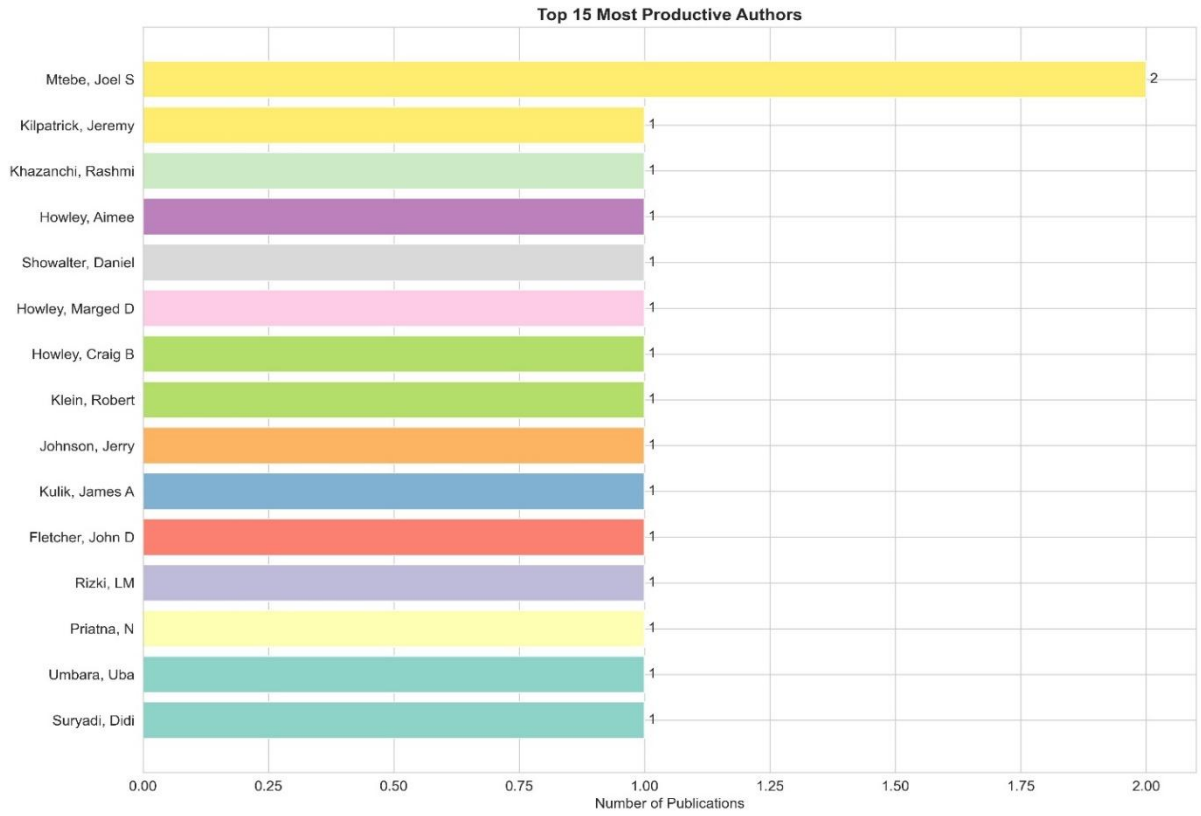

Figure 2: The plot unveils the most 15 influential authors in math for innovation publications
Source: Authors' Python simulation

Of the top countries producing study of how mathematics education drives innovation and self-employment, a clear divide arises between those with frequent and numerous publications and those effectively interpreting research into practical, transformative learning experiences. From Figure 3 While nations like Tanzania followed by the US lead in sheer output, studies from other countries highlight significant on-the-ground of less publications in integrating entrepreneurial ideas into the math curriculum.

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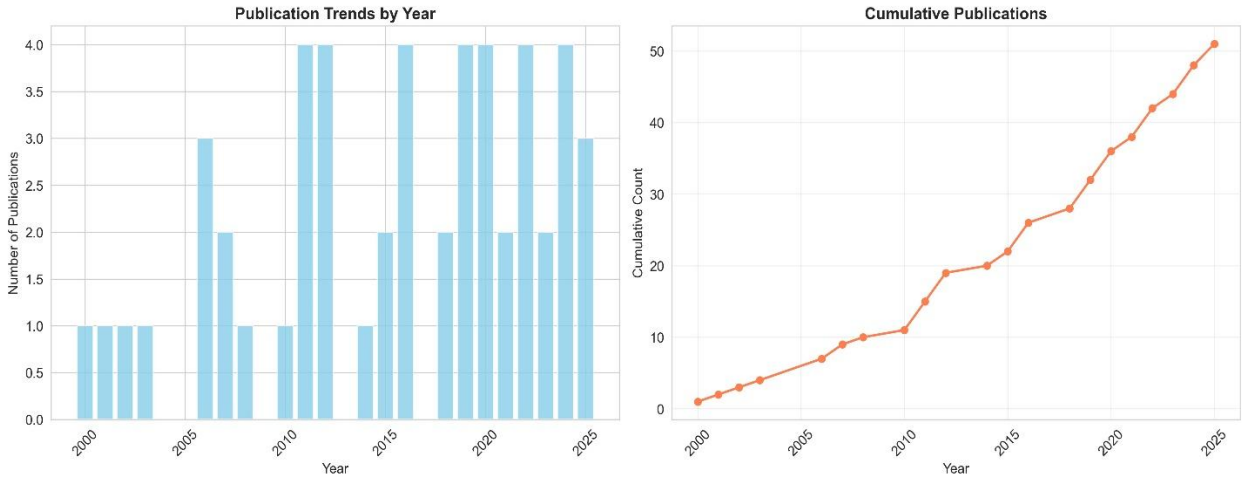

Figure 3: Histogram and Cumulative Curve for Publication Trends by Year
Source: Authors' Python simulation

This indicates that a high volume of math publications does not automatically associate to successful application; the most impactful study may come from education systems that bridge the gap between theoretical research, and classroom application to truly enhance the skills required for innovation and self-employment.

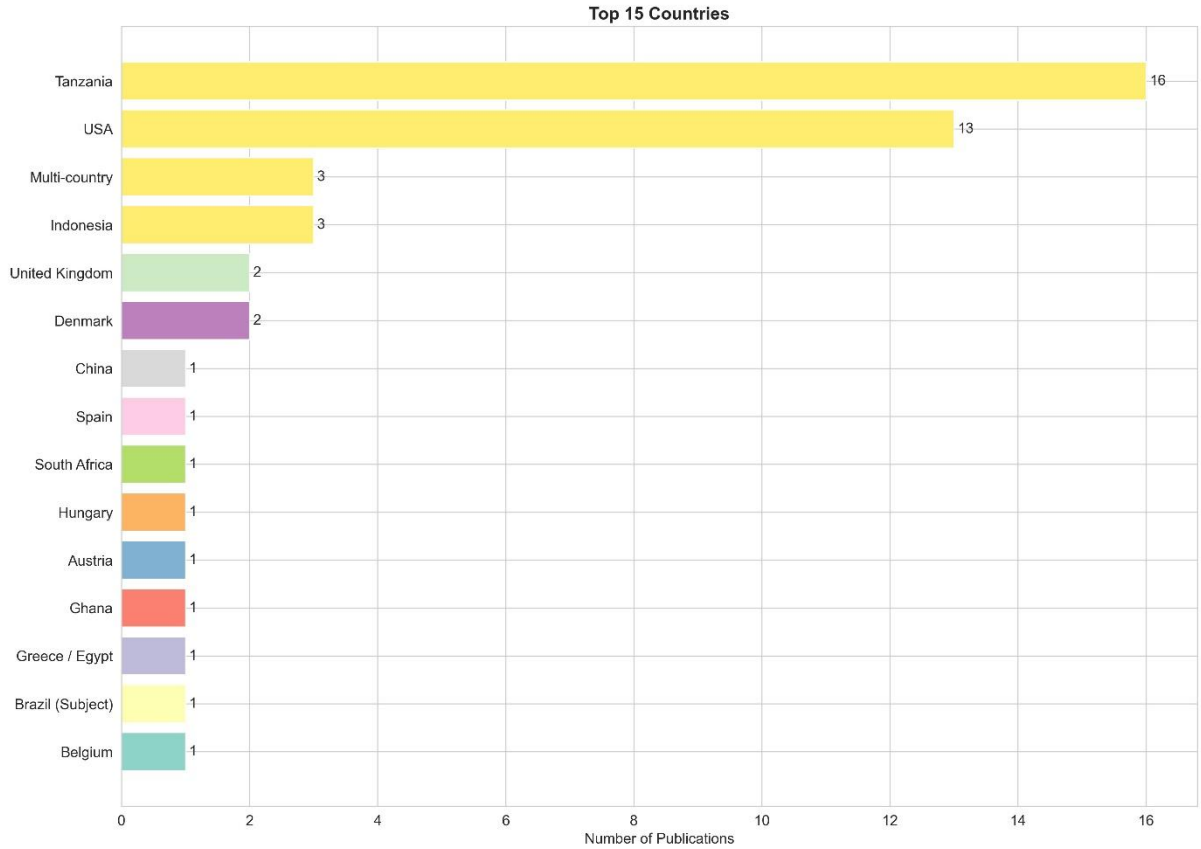

Figure 4: The plot shows top 15 countries in publications related to math for innovation and self-employment.
Source: Authors' Python simulation

Figure 4 shows publication sources orientated into the transformative study "Math for Innovation: Empowering Tanzanians Toward Self-Employment," a compelling description emerges: the most impactful article journals that bridge rigorous pedagogical math and innovation research with tangible, on-the-ground self-employment empowerment. These leading journals—spanning esteemed international mathematics, innovation education journals, and the related—collectively champion a robust model where mathematics is not merely a conceptual inquiry but a vital tool for promoting entrepreneurship, financial knowledge and self-sufficiency. Their curated study underscores the crucial importance of curricular contextualization, teacher training, and community engagement, suggesting how mathematical education can be a critical tool for modernisation and sustainable economic growth in Tanzania and beyond.

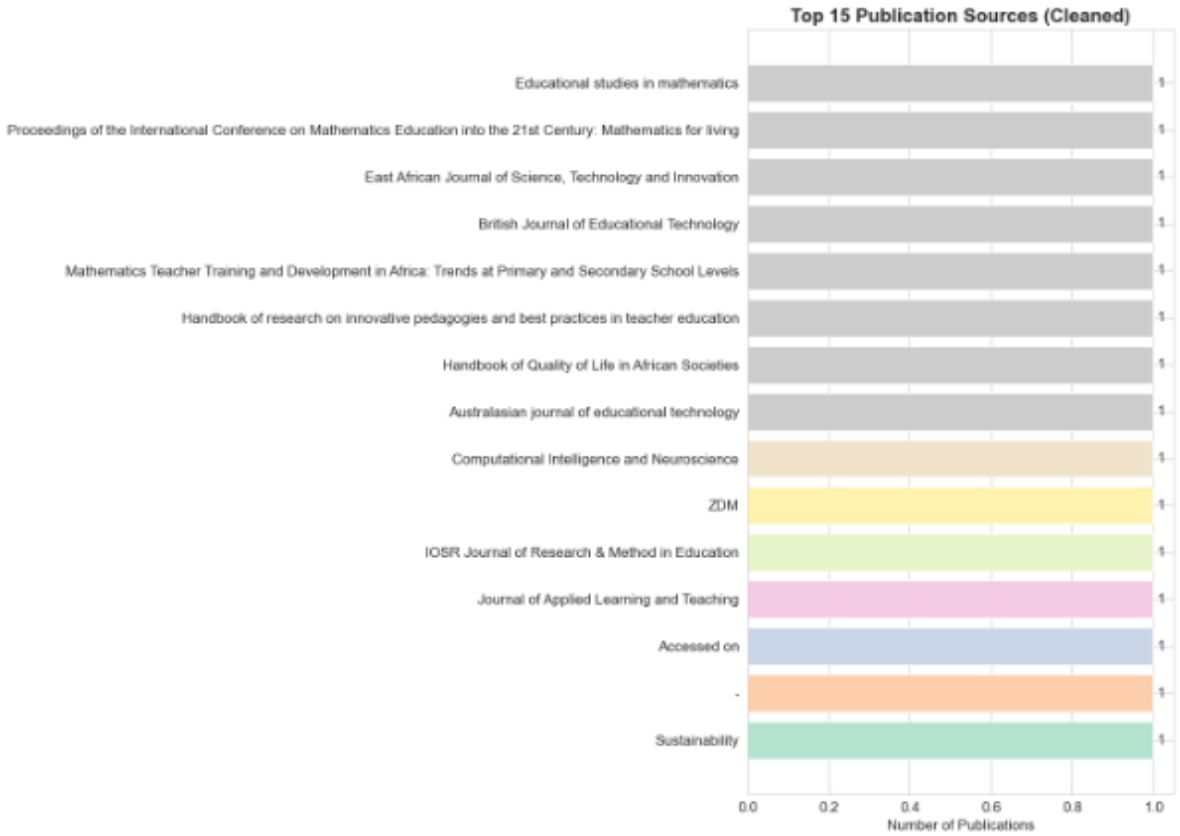

Figure 5: The plot shows top 15 publication sources related to math for innovation and self-employment.
Source: Authors' Python simulation

Figure A keyword network shows a lively scholarly milieu of a research field, changing thousands of publications into an appealing map of knowledge. By analysing the occurrence and co-frequency of keywords, this influential visualization exhibits the leading core themes—the large, central nodes—that form the basis of the discipline, while also emphasizing the emergent, interdisciplinary links—the thinner, bridging connections—that signal the frontiers of modernisation. In the framework of "math for innovation and self-employment," such a keyword network would powerfully demonstrate the merging of essential pedagogical terms like "problem-solving" and "innovation curriculum-based development" with dynamic notions such as "financial

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literacy," "entrepreneurial intent," and "local economic development. " This detailed web doesn't just map what researchers are examining; it tells a story of how purely theoretical entities are being actively entwined into the framework for capacity building, showcasing a field dynamically evolving to enhance critical thinking and innovation for solving real-world challenges.

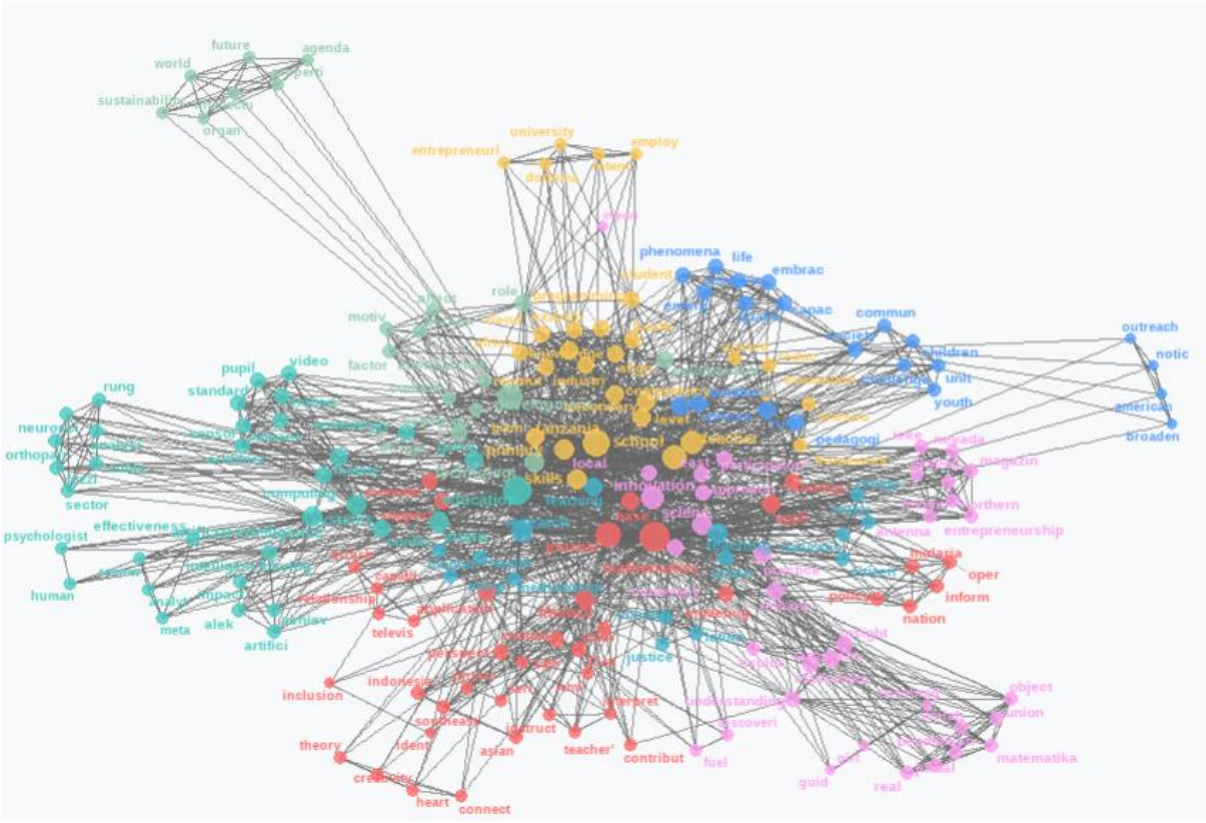

Figure 6: The plot shows keyword network to math for innovation and self-employment.
Source: Authors' Python simulation

4.1. Foundations of Mathematics for Innovation and Self-employment

On foundations of mathematics for innovation and self-employment perspective, the author assessed the study through reviewing the literatures explored on theoretical and conceptual foundations, education and curriculum development and gender, equity, and social inclusion. On global perspective, studies based on theoretical and conceptual foundations, the author examined mathematics proficiency performance and its impact on real life experience. The math scholars explored on mathematical literacy and confirmed that the skill varies with the values and rationales of the stakeholders who promote it and furthermore, the central argument is that it is not possible to promote a conception of mathematical proficiency without at the same time implicitly, or explicitly, promoting a particular social practice. The researchers further argued that the ability to understand and to evaluate these social practices should form a component of mathematical literacy (Jablonka, 2003). Amid the current 'math wars' in the United States, research evidence of the study designed to synthesize the literature on mathematics learning and to provide research-based recommendations, advice, and

guidance developed an elaborated view of mathematical literacy, termed *mathematical proficiency* in the study report found that research could be synthesized so that evidence from research might be used more productively for changing school mathematics in ways that would yield greater mathematical literacy for all (Kilpatrick, 2001). The purpose of mathematical proficiency is to ensure that all learners develop an understanding of mathematics, and how to relate mathematics to the world and use mathematical knowledge to make optimal and valuable decisions in their lives, work, and society. It can be seen that the purpose of mathematical proficiency coincides with the goal of education for sustainable development which aims at preparing future citizens to make informed decisions and take responsible action to solve problems (Chen et al., 2022)

According to Programme for International Student Assessment (PISA), Singapore scored significantly higher than all other nations in mathematics (575 points) and, along with Japan, Hong Kong (China), Korea, Macao (China), and Chinese Taipei, outperformed all other nations and economies in mathematics. Another 17 countries also performed in mathematics above the OECD average (472 points), ranging from Estonia (510 points) to New Zealand* (479 points). ▪ An average of 69% of students are at least basically proficient in mathematics in OECD nations. This implies that they are beginning to demonstrate the ability and initiative to use mathematics in simple real-life situations.

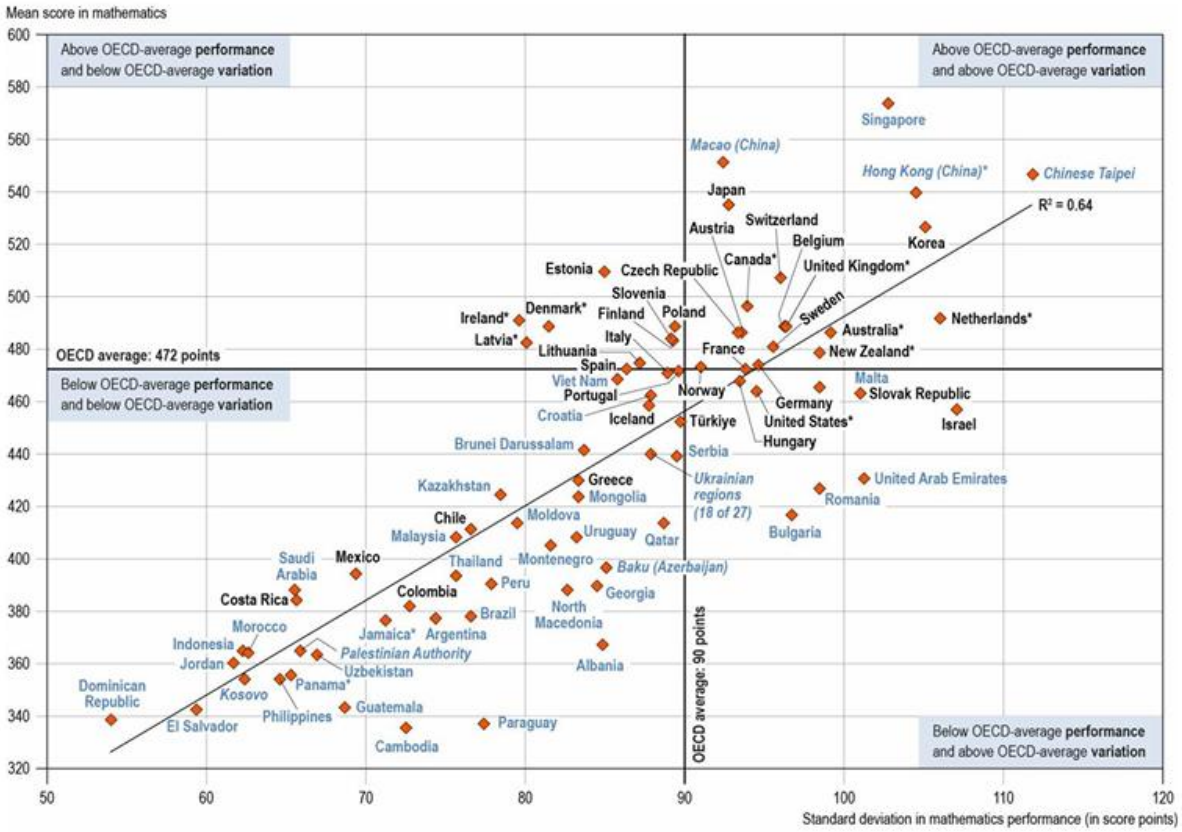

Figure 7: Average performance in mathematics and variation in performance
Source: OECD, PISA 2022 Database report, Table I.B1.2.1

In 16 out of 81 countries/economies partaking in PISA 2022, more than 10% of students attained Level 5 or 6 literacy degree, indicating they are high-performing: they understand that a problem is quantitative in nature and can develop complex mathematical models to solve it. By contrast, less than 5% of students are high performing in 42 nations as shown in Figure 6 and 7 (PISA, 2023).

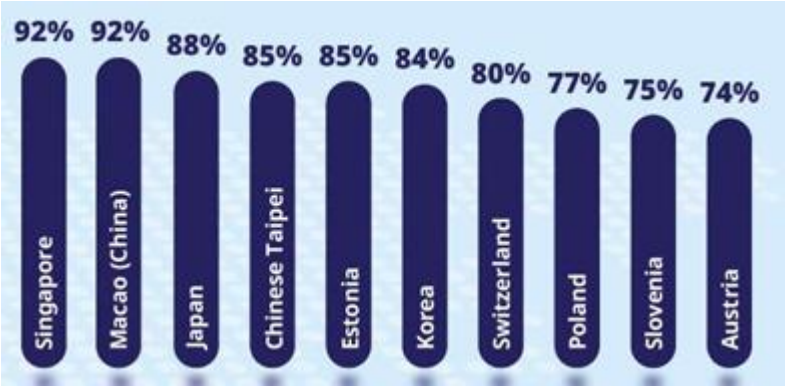

Figure 8: Percent of students at or above basic mathematics literacy performance
Source: OECD, PISA 2022 Report

According to Steen, Turner, and Burkhardt (2007), it is increasingly known that community can only tackle many of the challenges of modern life effectively if they are mathematically literate in key areas. In that respect, both primary and secondary school mathematics does not look so good and thus, most adults use little of the mathematics knowledge they first acquired in secondary school in their everyday lives. In the 21st the demands of the problem-solving skill in an occupation was increasing rapidly whilst mathematical literacy was still a major challenge in basic mathematics researches revealed that mathematical literacy was still foreign to some societies, yet it was important for the society (Widjaja, 2011). On the perspective of the role of mathematics literacy on innovation the author reviewed the previous literatures that linked with the subject matter. From the previous researches, it was found that, to function well in a technologically advanced society in 21st century, every educated person should be familiar with mathematics foundations that enhance multiple aspects of mathematical sciences which fuel innovation and discovery (Council et al., 2012). The contribution of mathematics on innovation and invention was also discussed in the location of the United States of which replete with examples of inventors and small business innovators. The scholars confirmed that, during the period from late 18th century to the present time, major technical advancements have been improved as a result of individual inventors, innovators, and entrepreneurs, working independently of large industrial corporations and the US government laboratories. These advancements were made by applying optimal curricula that support teaching about subjects like mathematics that relate to inventing, innovating, and being an entrepreneur (Kleppe, 2002)

On Tanzania context the author highlighted how mathematics and from the studies that investigated the numeracy competencies and unveiled that learning resources were one of the sources led inadequate teaching skills in mathematics. (Mmasa & Anney, 2016). The studies that show how curriculum influence mathematics literacy suggested the

need for curriculum reforms that involve the utilization of cutting-edge technology that enhances the numeracy skills. the implementation of deeper learning pedagogical approaches, and a concerted effort to consciously teach and emphasize interpersonal and intrapersonal skills, knowledge, and competencies (Ndunda, Lyeme, & Kasing'a, 2024). For further fostering of using technology on improving math literacy, teacher education colleges in Tanzania were being equipped with computers to prepare teachers who can integrate technology in teaching mathematics. Additionally, it was concluded that opportunities for pre-service teachers to participate in professional development programs that involve lesson design, teaching, evaluation and re-design, can be effective for the advance of the knowledge and skills of integrating technology in science and mathematics teaching (Kafyulilo, Fisser, Pieters, & Voogt, 2015; Madasi et al., 2022). There are limited literatures that discuss the influence of math literacy on innovation in Tanzania except that in the study that discuss a development project conducted in Tanzania which became known as "*hisabati ni maisha*" meaning mathematics is living/life with a goal of building capacity for mathematics teaching and learning in rural and remote communities. In the study, it was found that critical importance of mathematics project was the building and nourishing ongoing openness to emergent ideas (innovation) and strategies (Simmt, Binde, Glanfield, & Mgombelo, 2019).

4.1.1. The Influence of Math Anxiety on Mathematics Proficiency

Math anxiety is a widespread problem for all ages across the globe that mediates the mathematics performance in primary and lower secondary schools (Luttenberger, Wimmer, & Paechter, 2018). PISA studies confirmed that, a majority of adolescents found to worry and get tension in math classes and when doing math (PISA, 2023). It was further argued that within countries, mathematics anxiety is negatively linked with student achievement in mathematics in every education system that took part in PISA 2022 regardless of student and school characteristics. On average across OECD economic regions, a one-point increase in the index of mathematics anxiety is related with a decrease in mathematics achievement of 18 score points after accounting for students' and schools' socio-economic profile that determine also the role of fixed and growth mindset on math anxiety (*see* Figure 8-9). Countries/economies with higher average levels of mathematics anxiety perform less well in mathematics as also confirmed by the previous researches (Foley et al., 2017)

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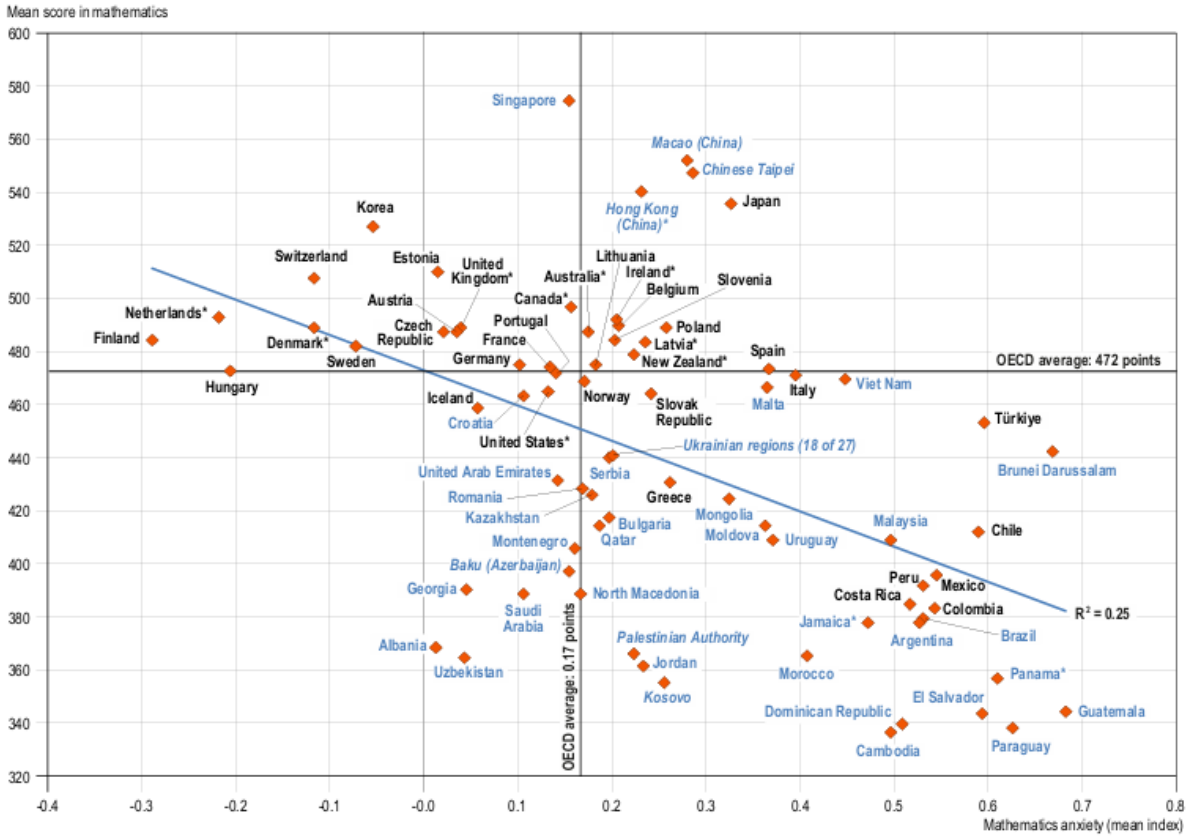

Figure 9: Mathematics anxiety and mean score performance in mathematics in PISA 2022

Source: OECD, PISA 2022 Database, Tables I.B1.2.1 and I.B1.2.16.

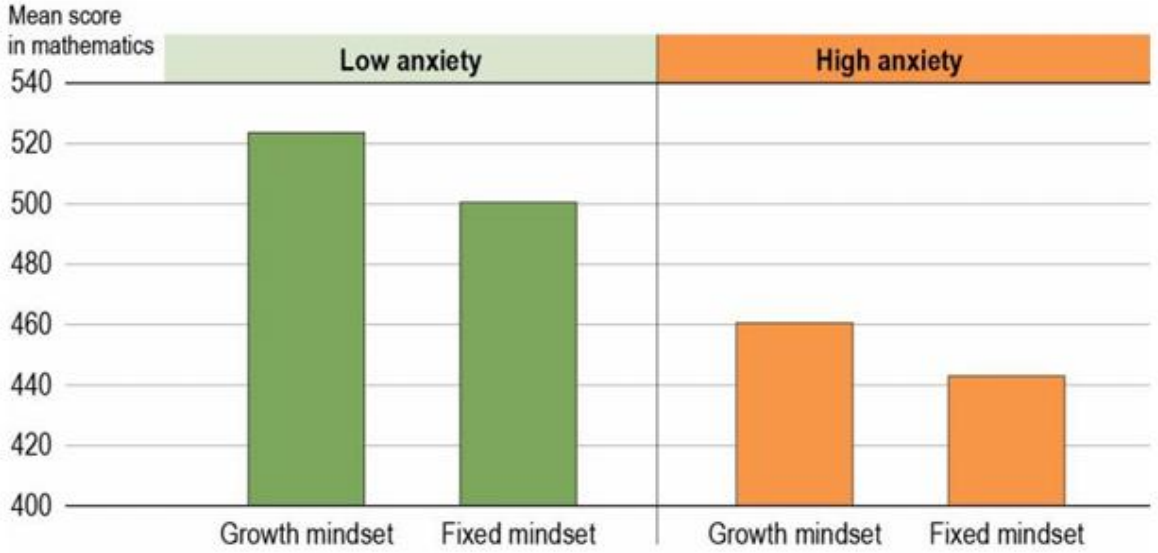

Figure 10: Mathematics performance and math anxiety among students with fixed and growth mindset

Source: OECD, PISA 2022 Database, Table I.B1.2.17.

Mathematics anxiety is also experienced in Tanzania and many scholars explored on searching the strategies of risk mitigations (Kinanda, Kyaruzi, & Fulgence, 2024). The study carried out in Singida District, students' performance in the final examination results for mathematics has been consistently low for the past six years and confirmed the influence of math anxiety on mathematics performance among secondary school students (Francis, 2024). The results further revealed that, fear of failing is influenced by the belief that mathematics lacks relevance to everyday life, inadequate teaching strategies due to lack of talent math skilled teachers, and comparisons with peers as the causative factors to mathematics anxiety

4.1.2. The Influence of Artificial Intelligence on Mathematics Proficiency

Recently, the integration of Artificial Intelligence into educational settings has been recognised as a transformative force, reshaping how mathematics should be taught, learned, and assessed. One of the most significant contributions of AI to mathematics education is the creation of personalized learning environments (PLE) that found to enhance student motivation and engagement in mathematics by tailoring instruction to individual needs, building mathematical confidence and supporting overall learning development (Kim, 2012). The role of AI algorithms is to analyse individual mathematics students' learning patterns, strengths, and weaknesses, enabling systems to tailor instruction accordingly (THOMAS, 2023). Tools like intelligent tutoring systems (ITS) and adaptive learning platforms (e.g., Carnegie Learning's MATHia, DreamBox) dynamically regulate the difficulty and style of problems demonstrated to each learner, promoting better student engagement and comprehension (VanLehn, 2011). Research confirms that personalized AI-based interventions can significantly enhance students' mathematical understanding, particularly for students who struggle with traditional instruction (Kulik & Fletcher, 2016). Such systems provide immediate, targeted feedback that is often unavailable in conventional classroom settings. One of the important AI tools is an Intelligent Tutoring Systems (ITS) and Virtual Assistants which employ AI to mimic one-on-one human tutoring by interpreting learner responses, diagnosing misconceptions, and providing step-by-step guidance (Koedinger & Corbett, 2006). Systems like ALEKS and ASSISTments have exhibited positive impacts on students' mathematical performance, especially in foundational skills such as algebra and problem-solving (Khazanchi, 2021). Many studies confirmed teaching and learning mathematics through games and activities can enhance math proficiency (Wiersum, 2012). The further argued that the effectiveness of human tutoring mathematics using games and activities improve the motivation of students. Therefore, researchers such (Garrido, 2010; Pillay, 2012) demonstrated how AI games like Sudoku influence motivated learning in Mathematics context. From the report of PISA (PISA, 2023) that indicated Singapore is a leading country in math literacy, the recent findings also revealed that educators in Singapore are most confident in AI's adaptability to cultural contexts which also enhance teaching and learning mathematics (Payadnya, Putri, Suwija, Saelee, & Jayantika, 2025).

In Tanzania, AI has not optimally been taken into account in mathematics education. However, AI in form of mathematical algorithms used in other disciplines as Mwogosi and Simba (2025) explored the integration of AI into teaching methodologies in health training in Tanzania. The researchers confirmed AI to enhance remote education opportunities and streamlined administrative processes when personalized learning

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(PEL) is incorporated. However, significant barriers such as limited technical skills among educators, insufficient infrastructure, financial constraints and resistance to technological change exist. The current study that demonstrated the role of real objects towards leaning mathematics confirmed that the real objects have significant implications for the teaching and learning of mathematics, as they exhibit that students become more actively engaged with mathematical concepts, while teachers foster their pedagogical practices in secondary school settings (Deogratias, Ngonyani, & Gadala, 2025). To support this type of motivated learning, educational researchers have developed computational environments (such as Arithmetic Video Game and other local games) that enable children to optimally engage in learning mathematics in a fun and motivated way (Bundotich, Murimi, Ntafatiro, Michael, & Nyambo, 2022; Mtebe & Isingo, 2024).

Beyond direct math student engagement discussed, AI plays an important role in supporting educators. AI-based platforms assist mathematics teachers in designing customized lesson plans, monitoring student progress, and predicting learning outcomes (Luckin & Holmes, 2016). AI further helps educators identify at-risk math students early and adjust instruction to meet diverse needs effectively. Additionally, AI-driven content generation—such as automatic problem creation and personalized homework activities—reduces mathematics teacher workload, allowing more time for high-value instructional assignments.

4.1.3. Applied Approaches and Empowerment Strategies

Mathematics has long been a foundational pillar of innovative ideas in science, engineering, economics, and technology (Anderssen et al., 2016). In this approach, the author examined the literatures that explore the field based which highlight successful self-employed Tanzanians who used math skills in innovative ways (e.g., agripreneurs, artisans using measurements, Boda Boda and Bajaji service schedulers). Additionally, the study investigated the role of Mobile Apps & Financial Tech like mobile banking, M-Pesa, and inventory apps use math to empower micro-entrepreneurs and Mathematical Modelling Software like Excel or Google Sheets being taught or used in small business training.

Globally, the researches explored the role of mathematical modelling, data analysis, and algorithmic thinking in driving innovation. According to Blomhøj and Kjeldsen (2006), mathematical modelling provides learners with the mathematical tools to abstract real-world problems and create solutions that can be tested and optimized. On the perspective of innovation, such skills are critical for prototyping, simulation, and optimization in both technological and social domains for emergent entrepreneurships. Additionally, project-based learning (PBL) and real-life problem solving are unveiled to bridge the gap between theoretical mathematics and practical application. De Corte, Verschaffel, and Greer (2000) argued that these mathematical pedagogies encourage creative thinking and connect mathematics to real-world outcomes, which foster emergent ideas from early stages of education. However, because creating mathematical connections is not only a product, but it is a process of connecting ideas in mathematics to ideas in mathematics and other disciplines, and real life and this

requires creative thinking, teachers can use making mathematical connection strategies and principles to promote students' creative processes in mathematics (Bicer, Bicer, Capraro, & Lee, 2023).

Empowerment approaches in mathematics often focus on access, equity, and relevance. According to Freire's theory of critical pedagogical teaching (Jackson, 2007), mathematical skills can be a powerful means of understanding and transforming societal structures. Gutstein (2003) used this framework in urban schools, showing that students who engross with math in a socially relevant context develop stronger problem-solving skills and a sense of agency. In rural and demoted communities, programs such as contextual mathematics curricula have proven effective in making abstract concepts more tangible that applied and, thus empowering learners to see mathematics as a tool for local innovation at located area.

According to Howley et al. (2011), information and communication technology plays a significant role in empowering students and professionals through mathematics. For instance, the integration of artificial intelligence (AI) and machine learning into mathematics education is creating new pathways for invention by allowing predictive modelling and advanced data handling. Moreover, mobile learning initiatives, especially in low-resource settings like in marginalized regions, are providing wider access to practical mathematics (Madasi et al., 2022; Voskoglou & Salem, 2020). Apps designed for market analysis, financial literacy, or logistics optimization are making mathematics practical and empowering for non-academic users in the community. Another imperative strand of the literature focuses on gender equity and inclusive education. The truism that boys are better than girls in mathematics has been challenged in many years and researches have shown that when girls and underrepresented groups are actively supported in mathematics through mentorship, culturally responsive pedagogy, and community engagement, they are more likely to contribute to emergent ideas ecosystems and thus, empowerment strategies must thus incorporate psychological and social support, alongside pedagogical reform.

Additionally, the truism that boys are better than girls in mathematics has been challenged in many years. Arguments suggesting that spatial ability is a primary genetic factor in mathematical achievement are considered, as are arguments based on social conditioning. It is concluded that, although spatial ability may affect performance, girls' diminishing achievement can largely be accounted for in social terms. Attitudes, rooted in the cultural milieu and reinforced by society, are probably the determining factor in whether or not girls succeed in mathematics (Halpern et al., 2007).

In Tanzania context, mathematics education plays an important role in national development, particularly in areas such as agriculture, engineering, technology, and economics. However, for mathematics to be a driver of emergent ideas, there must be a deliberate focus on applied learning methodologies and empowerment strategies that respond to the country's socio-economic realities. This literature review highlights how mathematical knowledge is being used and how learners and professionals are being empowered to apply it innovatively in Tanzania. The application of digital tools and mobile platforms is transforming mathematics education and innovation potential in Tanzania

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(Shao, 2014). Platforms such as Shule Direct, Ubongo, and Mathematics SMS tutoring services offer remote learning support, especially in areas with skilled mathematics teacher shortages (Darragh, 2021; Watson, Hennessy, & Vignoles, 2021). In addition, the growing tech ecosystem in Tanzania, especially in cities like Arusha and Dar es Salaam has led to a improve in interest in coding, data science, and fintech. These fields heavily rely on applied mathematics skills, and young Tanzanians are being empowered to create innovative and vibrant ideas through hackathons and bootcamps (Runge et al., 2020)

Responding to the above outcomes from the arguments, Tanzania has not taken enough initiatives towards using mathematics concepts on innovation as confirmed by researchers that mathematics plays a crucial role on promoting emergent ideas (innovation) (Anderssen et al., 2016). The results demonstrated the US and other developed countries like Singapore and OECD countries to apply mathematics in real-world experience through innovating new technologies. Furthermore, the increase of digital platforms in Tanzania, including e-commerce, mobile money services, and online freelancing, depends heavily on mathematical proficiency. Innovators and self-employed individuals must understand basic statistics, ratios, and trends to make informed decisions about marketing strategies, customer preferences, and inventory management. The Global Innovation index reported Singapore to hold 4th position in global innovation (Index, 2018) and the most math literate country followed by Macao (China) (PISA, 2023). This implies that, there is a significant relationship between math proficiency and innovation. For Tanzania to improve math proficiency, math anxiety should be mitigated as confirmed by Foley et al. (2017) that nations with higher average levels of mathematics anxiety perform less well in mathematics as indicated in Figure 3-4 and, the integration of AI should be maximized as confirmed by many researches that, AI has a pivotal role on mathematics performance (Mtebe & Isingo, 2024; Shao, 2014; Voskoglou & Salem, 2020). Emergent ideas promote self-employment and entrepreneurship (Ciarli, Di Ubaldo, & Savona, 2020). Innovation that brought by these new ideas depends on creative thinking encouraged by robust mathematical pedagogies that connect mathematics to real-world outcomes. In practice, self-employment in Tanzania can be uncertain. Therefore, the country can be achieved by promotion of applied approaches and empowerment strategies in learning mathematics. As suggested by Mtebe and Isingo (2024), Tanzania needs to increase the speed of implementing these applied approaches to accelerate the innovative skill using numbers thereby promoting the creation of self-employments. This study suggests mathematics community outreach to be taken into account for increasing student interest and involvement in mathematics-related activities since the outreach shows the exciting applications of mathematics, particularly to K-12 students. Outreach events allow an opportunity for mathematics students to discover an enjoyment and interest in mathematics along with minimizing the stigma associated with mathematics (Whitney, 2019)

Conclusion and Recommendations

This study aimed to understand the role of mathematics on emergent ideas (innovation) thereby empowering Tanzanians for self-employment which is the current challenge

experienced. 51 articles were cleaned and selected from 132 papers. Tanzania found to be dominant in the chosen articles that detail math for innovation with total papers 16 and publication rate found to rise cumulatively from the period of 2000 to 2025. Additionally, the study highlighted the foundations of mathematics for innovation and self-employment followed by application of mathematics concepts in real-world experience through empowerment strategies for enhancing critical thinking and problem-solving that build confidence to innovate.

In Tanzania, unlocking the potential of mathematics skills can transform the way individuals approach self-employment, from calculating profits and managing budgets to analysing the existing markets and optimizing business strategies. By harnessing practical math skills into vocational training and entrepreneurial education, the country can nurture a generation of self-reliant, innovative thinkers who are equipped to shape and strengthen sustainable livelihoods. Empowering Tanzanian students through numbers is not just about improving numeracy; it's about building a foundation for long-run economic growth, resilience, and inclusive development through emergent self-employments. The future of self-employment in Tanzania depends not only on new ideas, but on the ability to compute, adapt, and grow them—through the language of mathematics. To bridge the gap between theory and practice, this study recommends the integration of practical Mathematics into Tanzania Vocational Curricula to embed real-world math applications in entrepreneurship and vocational training programs.

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