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Global Trends in Contributing Factors to Mathematics Performance in Secondary Schools: Lessons for South Africa 2015 – 2024

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Abstract. This review of the literature examines global trends related to factors contributing to mathematics performance in secondary schools from 2015 to 2024, to draw lessons for South Africa. The study identifies key issues in South African mathematics education, such as insufficiently trained teachers, inadequate facilities, and lack of resources. It contrasts these factors with those of high-performing countries such as Singapore, China, Taipei, and Korea, which consistently excel in international assessments such as the TIMSS (Trends in International Mathematics and Science Study). The theoretical framework is grounded in complexity and chaos theory, emphasising the non-linear and dynamic nature of educational systems. The butterfly effect and chaos theory are used metaphorically to illustrate how small changes in initial conditions can lead to significant long-term impacts. Methodologically, the review employs a thematic analysis of literature sourced primarily from the Scopus database, covering a decade of research. After the initial selection procedure, 24 relevant articles were selected according to the predetermined selection criteria. The findings highlight the critical role of teachers, including their qualifications, professional development, and the establishment of a growth mindset. Furthermore, the importance of teaching and learning support, teacher-student relationships, resources, learning environment, and socioeconomic status is underlined. The review concludes that South Africa can improve its mathematics performance by ensuring that all mathematics teachers are well-qualified, providing adequate resources, and fostering a conducive learning environment. The study also recommends further research into early childhood development and a broader database search to enhance the understanding of factors influencing mathematics performance.

Keywords: contributing factors; globally; mathematics performance; secondary schools; South Africa

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1. Introduction

Mathematics performance, especially at the secondary school level, remains a significant topic of discussion among relevant role-players. In South Africa, experts have consistently expressed concerns about the quality of the country's mathematics education (Mabena et al., 2021; McCarthy & Oliphant, 2013; Spaull, 2019). Some limitations identified in the current system include a lack of well-trained mathematics teachers, inadequate teaching facilities, and the absence of primary resources for teaching and learning in South Africa (Bridgman, 2020). Furthermore, global performance in secondary school mathematics has also been shown to vary greatly across countries, with some of these demonstrating high levels of performance and others significantly underperforming. As mathematics is often a critical school subject for further studies at a tertiary institution of study, a lot of research has been conducted into poor mathematics performance at the secondary school level, but not much research has gone into which countries perform particularly well.

The TIMSS (Trends in International Mathematics and Science Study) is a well-known international assessment of mathematics and science for Grades 4 and 8 and the mathematics performance gap is an issue that is reported on every four years. Sixty-four (64) countries use the 2019 TIMSS data to monitor the effectiveness of their education systems and to place their performance within the global context. In 2019, the top-ranked country was Singapore with a score of 616 points, followed by Chinese Taipei with 612 points, and Korea with 607 points. The three countries with the lowest scores were Saudi Arabia (394), South Africa (389) and Morocco (388). A further concern is that the global TIMSS results are drawn from Grade 8 learner data, whereas in South Africa the participants are Grade 9 learners (Mullis et al., 2023).

However, the concern in South Africa lies not only in Grade 9 but also Grade 12. The Solidarity School Support Centre (SOS) (2023) reported in 2023 that only 248 491 of 691 160 Grade 12 candidates had Mathematics as a subject. Of these 248 491 candidates, 157 834 had passed the NCS exam. The conclusion from the 2023 results is that only 22,83% of the total number of Grade 12 candidates had ultimately passed Mathematics. Although there was a slight improvement of 1% from the 2020 to the 2023 results, the goal of the Department of Basic Education (DBE) must still be to enhance the Grade 12 Mathematics pass rate. UNESCO (2024) cites a lack of quality teachers and a focus on the quality of the grade 12 results instead of the quality of foundation phase mathematics teaching as two of the main contributors to the mathematics problem in South Africa. They reported that the neglect of Mathematics in the foundation phase has an impact on the Grade 12 Mathematics results as learners do not have sufficient basic numeracy and literacy skills.

However, despite the grim statistics for South Africa, there is also international cause for concern. Other African nations, such as Egypt, which performed below average, and Morocco, with the lowest scores in the 2019 TIMSS study (Mullis et al., 2023), have similarly shown poor performance, as is the case with Namibia. According to Hamukwaya and Haser (2021), Namibian educators have highlighted systemic, school-related, and student-related issues as contributing factors, with learners who are entering high schools lacking the required knowledge and skills. This is mainly due to being taught and assessed by unqualified teachers, leading to poor high school performance. Moreover, Maemeko et al. (2017) noted that Namibian teachers identified insufficient resources, inadequate school infrastructure, and lack of discipline as additional challenges. They also pointed out that students were unmotivated, with unsupportive home learning settings and inattentive parents who failed to support their children's academic efforts.

Further north, Skipp and Dommett (2021) have also expressed their concerns over the deficiencies in mathematics education in the United Kingdom. Based on the Global Annual Results Report for Education (UNICEF, 2024), there are globally still numerous learners who have failed to learn basic numeracy and literacy skills and consequently have no access to basic education.

It would be a mistake to interpret poor mathematics results as a general international trend. As stated above, according to Mullis et al., (2023) there are countries (especially Asian countries) showing great success in their mathematics education programmes. Drawing inspiration from those countries showing strong performance in secondary school mathematics, this paper aims to explore the factors that contribute to secondary school mathematics performance on the global stage and uses this data to draw lessons for the South African context. Therefore, the research questions for this paper are:

1. Globally, what are the contributing factors to strong mathematics performance in secondary schools?
2. What lessons may we draw from these trends for secondary schools in South Africa?

2. Theoretical Framework

Complexity and chaos theory, along with the notion of the butterfly effect, formed part of the theoretical framework of this study. Jacobson et al. (2019) have described education as a complex system that has conceptual and methodological implications for teaching. According to Kernick (2018), complexity theory is derived from chaos theory, but both share the following characteristics which apply to this study: nonlinearity, feedback, and self-organisation (Lartey, 2020).

The butterfly effect is dependent on initial conditions in nonlinear systems. In 1961, Edward Lorenz made the now-famous statement that, if a butterfly stirs its wings today in Beijing, it can in the next month unleash a storm in New York (Katamei & Omwono, 2015). As a metaphor, the butterfly effect is expressed as a variant of cause and effect at a distance, i.e. over time, changes occur in the atmosphere which would not have taken place had the butterfly not flapped its wings. Thus, according to Dooley (2009), the butterfly effect is a sensitive interdependence on initial conditions in nonlinear dynamic systems.

The butterfly effect holds great importance in the education sector. For example, the butterfly effect makes it impossible to predict the long-term effect of school improvement strategies. However, the metaphor of the butterfly effect becomes too general in further application, specifically when it comes to mathematics. In this case, chaos theory becomes applicable (Katamei & Omwono, 2015; Zaminpira & Niknamian, 2017). A small difference in the beginning can make a big difference in the long term. These systems are deterministic in nature, meaning that their future behaviour is fully determined by their initial conditions, with no random elements involved. The classroom, school, and entire community depend on one another and are affected by the relationships among them, whether good or bad (Dauphine, 2017).

Zaminpira and Niknamian (2017) noted that chaos theory focuses on dynamic systems that are extremely sensitive to initial conditions. They explain that, within the chaotic system, there is reliance on programming at the initial point, which is dependent on initial conditions, underlying patterns, constant feedback, repetition, fractals, and self-similarity. According to Katamei and Omwono (2015), the teacher is the agent of chaos in the classroom. The teacher drives many of the reactions of the other agents in the classroom, which makes the teacher the most chaotic element in the classroom. Even the failure to decide is a decision, which, in turn, contributes to chaos.

The question then arises as to how thinking about chaos theory helps teachers. The answer, in short, is that it is helpful when teachers view uncertainty in the same way that chaos theorists do. Since they cannot account for every single variable in the school environment, teachers should approach each task with a readiness to deal with any eventuality. Since teachers cannot be certain about results, they should follow their discretion, based on their education and experience, when, for example, designing a lesson. This is a wise view, and one held by many educators who do not actively think of the phenomenon of chaos. A school is a complex organisation as chaos theory confirms the existence of complex organisations (Daryani & Amini, 2016).

3. Methodology

This research aims to uncover global trends contributing to mathematics performance in secondary schools as related to the field of mathematics education. To detect these trends, this systematic review is outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement developed by Page et al. (2021). PRISMA allows scholarly authors to assemble detailed systematic reviews that capture researchers' interests. Additionally, it assists readers in thoroughly comprehending the research subject and in uncovering new questions for further study (Aifang et al., 2024; Li et al., 2024). According to Pazin et al. (2022), PRISMA provides three major benefits in that it 1) develops specific research questions that facilitate the execution of systematic research; 2) establishes criteria for inclusion and exclusion; and 3) analyses broad literature database(s) over a defined timeframe. The methodology for this review was developed in accordance with these three criteria.

3.1 Research Design

Figure 1 illustrates the research design that was adopted for conducting the investigation. The initial search was derived from the research questions guiding this study. After the initial search, a search for relevant literature was conducted. Via the inclusion and exclusion criteria, articles with the strongest relevance were extracted from the database and used for the data analysis (Adeniji et al., 2022).

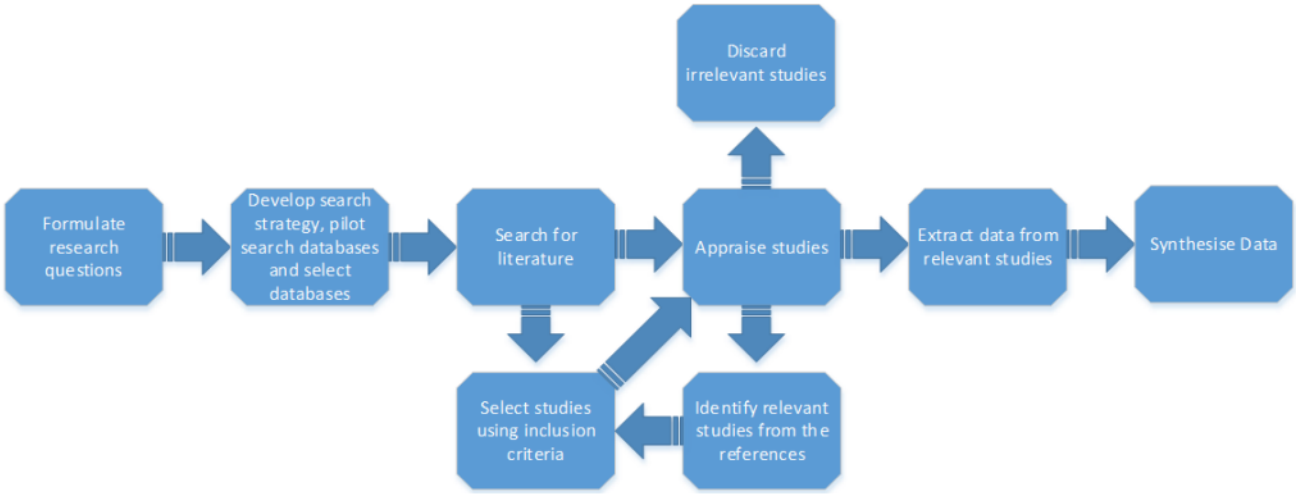

Figure 1: Diagrammatic representation of the research methodology (Adeniji et al., 2022)

3.2 Data Collection

Figure 2 is a diagrammatic representation of the data collection process.

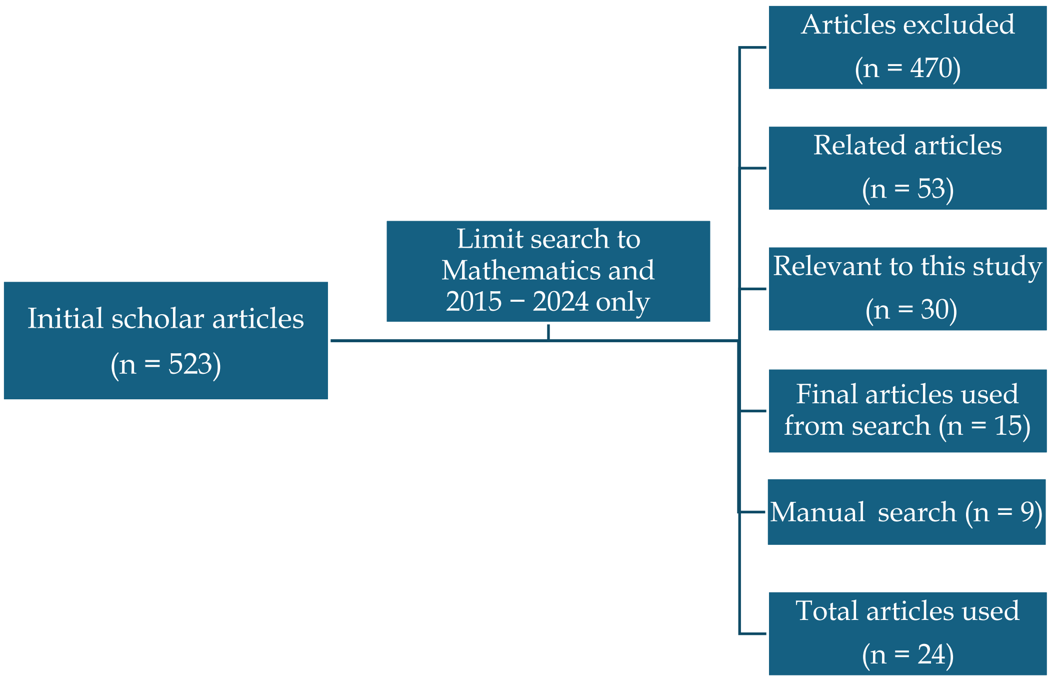

Figure 2: Schematic diagram of the data collection process

In preparation for the initial search, the following search was conducted within the Scopus database. The search was done within the *"Article title, Abstract, and Keyword"* fields of the search engine. The document search was then expanded by keywords ("trends" OR "factors" OR "contributors") AND ("secondary schools" OR "high schools") AND ("mathematics" AND "performance"). In relation to this search with no further subject and date filter, a total of 523 articles was found. After the initial search, a further search was conducted limited to mathematics only and limited to a timeline between 2015–2024. A total of 52 articles were published from that specific search. Of the 52 articles, 22 articles were not related and consequently omitted (not relevant) from the search. In the last search of 30 journal articles, a further 15 articles were eliminated which brought the final search to 15 journal articles. Eight relevant articles from Scopus were manually added. These literature sources were added as being related to the topic and fall within the specific timeframe and the Scopus database.

3.3 Exclusion Criteria

The three focus areas of this study are secondary school, mathematics, and the timeframe of 2015–2024. Any other literature searched outside these criteria was excluded. The greatest initial exclusion came about when mathematics only and the specific timeframe were added to the search. Thereafter, the focus fell on secondary schools, so all the literature searches outside secondary schools (primary schools and tertiary institutions) were also eliminated.

3.4 Data Sources

A pre-search on the topic was conducted to determine the preferred literature from which to select a figure-appropriate database. The Scopus database was used as the primary database. The publication dates for the search are from 2015 to 2024 (10 years). The timeline selected meant that research results from before the COVID-19 pandemic, during the pandemic, and after the pandemic would be included. Certain literature sources from within the timeline were also used but had not been obtained in the initial Scopus search.

3.5 Data Analysis

The data-analysis approach used for this review was thematic analysis. Nowell et al. (2017) mentioned that thematic analysis was employed and found to be very useful as it is flexible and aligns with multiple paradigms. Table 1 indicates the contribution of each article to mathematics performance in the selected countries.

Table 1: List of publications indicating contributing factors to mathematics performance in secondary schools from different countries for the period 2015–2024

	Literature reviewed	Country	Title	Journal	Contributing factors
1	Ko et al. (2024)	USA	Understanding the characteristics of mathematical knowledge for teaching algebra in high schools and community colleges	International Journal of Mathematical Education in Science and Technology, *55*(3), pp. 590-614	- Teacher experience - Subject-specific teachers
*2	Stohlmann and Yang (2024)	USA	Growth mindset in high school mathematics: A review of the literature since 2007	Journal of Pedagogical Research, *8*(2), pp. 357-370	- Growth mindset

*3	Amalina and Vidákovich (2023)	Hungary	Cognitive and socioeconomic factors that influence the mathematical problem-solving skills of students	Heliyon, *9*(9)	- Socio-economic status
4	Murphy (2022)	Australia	Mathematics success against the odds: the case of a low socioeconomic status, rural Australian school with sustained high mathematics performance	Mathematics Education Research Journal, *34*(4), pp. 767-787	- High expectations - Learning support - Teacher quality
5	Malvasi and Gil-Quintana (2022)	Italy	Beliefs, performance, and applicability of mathematics in learning for life: The multi-case study at secondary education institutes in Italy	Journal on Mathematics Education, *13*(1), pp. 51-56	- Beliefs about mathematics
6	Chand et al. (2021)	Fiji	Perceived causes of students' poor performance in mathematics: A case study at Ba and Tavua secondary schools (Open Access)	Frontiers in Applied Mathematics and Statistics 7,614408	- Teacher qualifications
7	Hamukwaya and Haser (2021)	Namibia	"It does not mean that they cannot do mathematics": Beliefs about mathematics learning difficulties	International Electronic Journal of Mathematics Education, *16*(1), em0622	- Teacher education programs to improve knowledge, practices, and beliefs.
*8	Skipp and Dommett (2021)	UK	Understanding and addressing the deficiencies in UK mathematics education: Taking an international perspective	Education Sciences, *11*(3), 141	- Teacher autonomy and expectations - Continuous Professional Development (CPD)

9	Trujillo-Torres (2020)	Spain	Estimating the academic performance of secondary education mathematics students: A gain lift predictive model	Mathematics, Open Access, Volume 8, Issue 12, pp. 1–23 December 2020, Article number 2101	- Role of classroom - Student-teacher relationship
10	Gómez-García and Melchor (2020)	Spain	Technological factors that influence the mathematics performance of secondary school students	Mathematics Open Access Volume 8, Issue 11, pp. 1–14 November 2020, Article number 1935	- ICT
11	Mazana et al. (2020)	Tanzania	Assessing students' performance in mathematics in Tanzania: The teacher's perspective	International Electronic Journal of Mathematics Education Open Access Volume 15, Issue 3 October 2020, Article number em 0589	- Learning environment - Teacher training
12	Herbert et al. (2020)	Australia	Characteristics of a secondary school with improved NAPLAN results	Mathematics Education Research Journal *32*(3), pp. 387-410	- Curriculum - Teachers - School policies and practices - Growth mindset - Professional learning
13	Zamora-Araya (2020)	Costa Rica	Impacts of attitudes, social development, mother's educational level and self-efficacy on academic achievement in mathematics	Uniciencia Open Access Volume 34, Issue 1, pp. 74-87	- Attitude towards mathematics
*14	Yin et al. (2020)	China	Linking university mathematics classroom environments to student achievement: The mediation of mathematics beliefs	Studies in Educational Evaluation, 66, p. 100905	- Learning environment
15	Alzahrani and Stojanovski (2019)	Australia	Evaluation of mathematics teaching strategies in Australian high schools	23rd International Congress on Modelling and Simulation - Supporting Evidence-Based Decision Making: The Role of Modelling Simulation, MODSIM 2019 pp. 905-910	- Student-teacher relationship - Classroom management - Teacher support

16	Zhu et al. (2018)	China	Gender equity in mathematical achievement: The case of China	Educational Studies in Mathematics, *99*(3), pp. 245-260	- Socio-economic status
*17	Lan and Moscardino (2019)	China	Direct and interactive effects of perceived teacher-student relationship and grit on student well-being among stay-behind early adolescents in urban China	Learning and Individual Differences, Volume 69, January 2019, pp. 129-137	- Student-teacher relationship
18	Oyesiku (2018)	Nigeria	An educational math game for high school students in Sub-Saharan Africa	Communications in Computer and Information Science, 942, pp. 228-238	- Mathematical games
*19	Olivier and Archambault (2017)	Canada	Hyperactivity, inattention, and student engagement: The protective role of relationships with teachers and peers	Learning and Individual Differences, 59, pp. 86–95	- Student-teacher relationship
*20	Cadime et al. (2016)	Portugal	Well-being and academic achievement in secondary school pupils: The unique effects of burnout and engagement	Journal of Adolescence, 53, pp. 169-179	- Resources
*21	Tosto et al. (2016)	UK	From classroom environment to mathematics achievement: The mediating role of self-perceived ability and subject interest	Learning and Individual Differences, 50, pp. 260-269	- Environment
22	Han et al. (2015)	USA	How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle and low achievers differently: The impact of student factors on achievement	International Journal of Science and Mathematics Education, *13*(5), pp. 1089-1113	- Socio-economic status

23	Pedersen (2015)	Norway	What characterizes the algebraic competence of Norwegian upper secondary school students? Evidence from TIMSS advanced	International Journal of Science and Mathematics Education, *13*(1), pp. 71-96	- Teaching resources
*24	León and Valdivia (2015)	Peru	Inequality in school resources and academic achievement: Evidence from Peru	International Journal of Educational Development, 40, pp. 71-84.	- Resources

*Manually searched articles

4. Findings

The following sections provide an in-depth analysis of the various aspects investigated in this review, offering insights into the global trends that constitute contributing factors to mathematics performance in secondary schools. Lessons for South Africa will be drawn from this data.

4.1 Country and Respondents

The studies in this review originate from diverse countries in the international scene. Three of the articles are from the USA (Han et al., 2015; Ko et al., 2024; Stohlmann & Yang, 2024), three from Australia (Alzahrani & Stojanovski, 2019; Herbert et al., 2020; Murphy, 2022), eight from Europe (Amalina & Vidákovich, 2023; Cadime et al., 2016; Gómez-García & Melchor, 2020; Malvasi & Gil-Quintana, 2022; Pedersen, 2015; Skipp & Dommett, 2021; Tosto et al., 2016; Trujillo-Torres, 2020), three from Asia (Lan & Moscardino, 2019; Yin et al., 2020; Zhu et al., 2018), and three from the African continent (Hamukwaya & Haser, 2021; Mazana et al., 2020; Oyesiku, 2018). The remaining participating countries in this review are Fiji, Peru, Canada, and Costa Rica (Chand et al., 2021; León & Valdivia, 2015; Olivier & Archambault, 2017; Zamora-Araya, 2020, respectively). As mentioned, the timeframe for data collection constituted articles that were published between 2015 and 2024. Ten of these articles appeared before the pandemic (2015 – 2019), nine articles during the pandemic (2020 – 2021) and five articles after the pandemic (2022 – 2024).

4.2 Data Collection Methods

This review explored a variety of the data collection techniques and instruments utilised within the various studies, such as appreciative inquiry, case studies, quantitative and qualitative research, mixed-method approaches, report analysis, and systematic reviews. The instruments applied in these studies consisted of questionnaires, interviews, classroom observations, mathematics tests, and evaluations. These varied tools offered unique perspectives on worldwide trends in mathematics performance in secondary schools.

The quantitative data collection method was the most frequently used approach. Fourteen studies adopted quantitative data collection only, with questionnaires constituting the primary form of data collection. Ko et al. (2024) used a pre- and post-test with the same instrument to test teacher's knowledge. Murphy (2022) offered a case study and employed a conceptual framework influenced by Appreciative Inquiry and the theory of Practice Architectures to investigate the factors that led to the school's achievement in mathematics. The remainder of the studies used questionnaires as their method of data collection (Amalina & Vidákovich, 2023; Cadime et al., 2016; Gómez-García & Melchor, 2020; Han et al., 2015; Lan & Moscardino, 2019; León & Valdivia, 2015; Olivier & Archambault, 2017; Tosto et al., 2016, Trujillo-Torres, 2020; Pedersen, 2015; Yin et al., 2020; Zamora-Araya, 2020).

Three studies employed mixed methods approaches. The data collection methods employed varied from a combination of mathematics tests, questionnaires, interviews and observations (Chand et al., 2021; Malvasi & Gil-Quintana, 2022; Mazana et al., 2020). Two other studies used qualitative approaches with semi-structured interviews and observations as data collection methods (Hamukwaya & Haser, 2021; Herbert et al., 2020). Two of the studies used reviews to collect data. That is, Stohlmann and Yang (2024) conducted a systematic review of the literature since 2007 and Skipp and Dommett (2021) considered the state of mathematics education in the UK after the underwhelming results in the Programme for International Student Assessment (PISA) metric, which evaluates reading, science, and mathematics across 27 countries.

The remaining three articles consist of two analyses of data and a presentation. One of the analyses looks at data from the 2012 PISA study, focused on Australian high school students and assessing the possible impact of different teaching methods on mathematics performance (Alzahrani & Stojanovski, 2019). Another study analysed the difference in mathematics performance according to gender, also using PISA data (Zhu et al., 2018). Lastly, Oyesiku's (2018) study developed educational gaming software designed to boost students' interest in mathematics and aid them in comprehending and enhancing their performance in the subject.

4.3 Findings from Collected Data

The findings obtained from the 24 articles vary in many ways. The findings reveal that there are common global factors that contribute to mathematics performance in secondary schools. A summary of the contributing factors is found in Table 2.

Table 2: Summary of factors contributing to mathematics performance in secondary schools according to the literature review

	Contributing factors	Literature
1.	Factors relating to teachers and teacher quality	Chand et al. (2021) Hamukwaya and Haser (2021) Herbert et al. (2020) Ko et al. (2024) Malvasi and Gil-Quintana (2022) Mazana et al. (2020) Murphy (2022) Skipp and Dommett (2021) Stohlmann and Yang (2024) Zamora-Araya (2020)

2.	Factors relating to teaching and learning support	Alzahrani and Stojanovski (2019) Cadime et al. (2016) Gómez-García and Melchor (2020) Herbert et al. (2020) Lan and Moscardino (2019) León and Valdivia (2015) Murphy (2022) Olivier and Archambault (2017) Pedersen (2015) Tosto et al. (2016) Trujillo-Torres (2020) Yin et al. (2020)
3.	Factors relating to the socio-economic status of the school	Amalina and Vidákovich (2023) Han et al. (2015) Zhu et al. (2018)
4.	Factors relating to mathematical games	Gómez-García and Melchor (2020)

The findings listed in Table 2 will be used in discussing and responding to the research questions posed in this paper.

5. Discussion

A thematic analysis of the literature yielded certain themes and sub-themes as global contributing factors to mathematics performance in secondary schools. Although there are many contributing factors to mathematics performance in secondary schools, the findings below are limited to the search as indicated in Tables 1 and 2.

5.1 Global Contributing Factors to Mathematics Performance in Secondary Schools

The implementation of the benefits of PRISMA (see 3) contributes to the most common contributing factors globally through the systematic review discussed below to answer the first research question. Some of the factors identified in Table 2 are discussed below.

5.1.1 *Teacher quality*

A few years ago, a report by the Sutton Trust (2011) indicated that the difference between an effective teacher and an average teacher, especially among disadvantaged students, can be between 25 – 45%. Therefore, the first contributing factor to mathematics performance constitutes teachers' contribution to the class. Ko et al. (2024) stated that the mathematics knowledge of teachers in the USA has been named as one of the most important resources for effective education. It was proven that learners of teachers who had followed an advanced mathematics course did much better than those who did not. A study by Stohlmann and Yang (2024) emphasises the importance of a growth mindset in the mathematics classroom. Middle and high school mathematics teachers in the US collaborate to develop a growth mindset concerning mathematics. This growth mindset was found to have a significant impact on students' beliefs about their mathematics performance. In Italy, teachers found a correlation between self-belief in mathematics and academic performance and emphasised the importance of teachers instilling self-belief into the learners (Malvasi & Gil-Quintana, 2022).

Furthermore, in Australia, Murphy (2022) conducted a study in rural areas where the availability of resources is limited. However, they found that building mathematics teachers' capacity improved mathematics education overall. The mathematics teachers engage through a professional learning community (PLC) to discuss challenging mathematics-related topics. Murphy (2022) also found that individual professional development (PD) among teachers contributes to producing better mathematics teachers in the classroom. To add to the importance of PD, Skipp and Dommet (2021) stated that Japan includes subject-specific development as part of the community of practitioners; a community that is also led by teachers.

However, Chand et al. (2021) reported that although in Fiji, mathematics performance is not great, the teachers who teach mathematics must be fully qualified and positive towards the subject in order for them to improve the subject in their school system. Furthermore, in Tanzania, teachers' method of instruction was also found to be very important for successful teaching and learning. The quality, quantity, culture, content clarity, structural organisation, and assessments all form part of the teacher's instructional duties. Mazana et al. (2020) stated that the quality of teacher instruction in terms of the mentioned aspects contributes to academic performance in a school.

One of the mentioned cultures constitutes the teacher's expectations in a mathematics classroom (Murphy, 2022). In Skipp and Dommett (2021), they argued that the lack of teacher expectations is part of the decline in mathematics performance. This is in contrast with Asian countries like China, Singapore, Japan, and South Korea, where the teachers have very high expectations of their learners. In Japan, the learners are not grouped in sets of abilities until they are 14 years old, which illustrates the belief amongst the teachers that every learner can achieve a desired level of mathematical proficiency (Skipp & Dommet, 2021).

In Australia, Herbert et al. (2020) found that teachers' enjoyment and enthusiasm for teaching mathematics and understanding the subject, rather than memorising the subject, played a role in improving The National Assessment Program – Literacy and Numeracy (NAPLAN) results. Also in Australia, Alzahrani and Stojanovski (2019) stated that the teachers who support their learners remind them to work hard, assist students by providing extra assistance with their mathematics learning, and allow the learners to express their opinions.

Lastly, teachers must strive to enable a growth mindset and a positive attitude towards mathematics when teaching the subject. In the USA and Australia (Herbert et al., 2020; Stohlmann & Yang, 2024) the teachers were found to encourage growth mindsets within the mathematics classroom to foster growth and learn in the subject. The growth mindset assists in students having a positive attitude toward mathematics which also contributes to strong mathematics performance (Malvasi & Gil-Quintana, 2022; Zamora-Araya, 2020).

5.1.2 *Teaching and learning support*

This study is grounded in chaos theory with non-linearity as one of its characteristics. The non-linearity implies that it is not only a single factor that contributes to mathematics performance in a school system. Therefore, teaching and learning support can be added as a contributing factor to mathematics performance in secondary schools. In Australia, Murphy (2022) found that providing proactive learning support is associated with higher performance in mathematics. However, within teaching and learning, some sub-themes also contribute to mathematics performance.

a) *Teacher-student relationship*

In Spain, Trujillo-Torres (2020) stated that the teacher-learner relationship has the greatest influence on mathematics performance, even greater than motivation, resources, teaching, and teaching time. Further South in Australia, in a study by Alzahrani and Stojanovski (2019), they reported that the teacher-student relationship had a significant impact on learners' mathematics performance in secondary schools. According to Lan and Moscardino (2019), positive student relationships in China are fundamental to their schools' success. The learners feel safer and more competent within the school. Their point of view agrees with that of Olivier and Archambault (2017) who in Canada found that a positive student-teacher relationship facilitates strong connections between classmates which is linked to better academic performance.

b) *Resources*

Pederson (2015) stated that in Norway, teachers devote more teaching resources to make sure algebra is taught in a transformational way and to manipulate symbolic expressions efficiently. Murphy (2022) noted that Australia provides learning support resources to help maintain high mathematics performance in a rural school situated in a low socioeconomic area. Furthermore, in Peru, León and Valdivia (2015) indicated that school resources had a significant impact on mathematics performance. Schools in poorer communities had access to fewer resources which in turn had an impact on academic performance, especially in mathematics. In Portugal, Cadime et al. (2016) found that the availability of adequate resources enhances teaching practices. If there are study and personal resources available, this yields positive outcomes in terms of self-efficacy and engagement, which all ultimately have an impact on academic performance.

In Spain, Gómez-García and Melchor (2020) stated that about 59% of educational centres use mobile phones as an education resource. The use of mobile phones as a resource influences academic performance positively, regardless of how they are used. They found that the correct use of information communication and technology (ICT) enhances academic performance and improves the learning environment.

c) *Learning environment*

Apart from the resources, the learning environment also serves as a contributing factor to mathematics performance. Trujillo-Torres (2020) is of the view that the classroom has one of the greatest influences on mathematics scores in Spain. On the African continent, Mazana et al. (2020) stated that mathematics performance was not up to standard, and they prioritise the enhancement of the teaching-learning environment to improve mathematics performance. In the UK, Tosto et al. (2016) stated that the learning environment indirectly influences interest in a subject and in learners' self-concept. The interest and self-concept then mediate the relationship between classroom environment and mathematics performance. In China, one of the leading countries in mathematics, a conducive classroom environment is related to higher mathematics performance and better affective and cognitive mathematics outcomes (Yin et al., 2020).

5.1.3 *Socio-economic status of the school*

In the USA, Han et al. (2015) found that the socio-economic status (SES) of the learners influenced their academic performance in mathematics. They found that the higher the SES, the better the performance, and vice versa. In Hungary, where they focussed on mathematical problem-solving, Amalina and Vidákovich (2023) emphasised the importance of the SES factor in mathematics success. Their first indicator within the SES was parents' educational level and family income. Positive behaviours and beliefs in mathematics are more prominent in households with better SES and the provision of extra material resources is also influenced by family income. Furthermore, Murphy (2022) reported that in Australia, performance in rural and low socio-economic areas is much lower than in the urban areas. He stated that learners in these areas have lower academic aspirations and are not always interested in pursuing a career in mathematics. Therefore, the motivation and willingness to do well in mathematics is very low. Many teachers are also not willing to go to schools within a low SES community and therefore the schools do not attract very good mathematics teachers. The low mathematics performance in South Africa is of great concern, meaning that any lessons that can be drawn from the global context can be of great help to learners in our schools. The next section points out what these lessons might be.

5.2 Lessons Drawn from International Trends for Secondary Schools in South Africa

As stated (see 1.1), South Africa performs poorly in mathematics when surveyed globally. Theron (2016, 2022) mentioned that, despite this largely poor performance, there are certain schools in South Africa that do perform well in mathematics. South Africa can gain a lot from looking at global trends in order to improve the country's mathematics performance. The first of these lessons concerns making sure that all mathematics teachers are qualified and have sufficient knowledge of their subject. Arends (2025) reported that mathematics teachers from South Africa were found to be those with the lowest qualifications.

As stated in the findings, the quality and quantity of teaching and support are very important. Arends (2025) stated that 12% of the learners did not even have a textbook to work from and only 48% of learners in free public schools are fortunate enough to be in classes with less than 40 learners per class. In terms of the school environment and climate, only 31% of all schools emphasise academic success with the most concerning statistic being that only 18% of learners attend a safe and orderly school.

From these findings around the world, lessons for South Africa are similar to what White and van Dyk (2019) found in their study. They stated that instead of an umbrella approach in terms of funding to schools, South Africa must rather follow an approach that is more geared towards educational needs. Low SES schools are associated with poor academic performance, but instead of just giving them money, the focus should be placed on teachers, leaders, and developing the people within the system. They further stated that the culture and climate of the school must be prioritised instead of just providing more and more money to schools. The last lesson is that resource equity must be established. Resource equity refers to the study's findings in terms of people (teachers) as well as teaching and learning support.

Given the worrying signs detected in this study, South Africa must ensure that the DBE ensures that all schools have sufficient resources and that the learning environment is conducive to teaching and learning. Prof. Jonathan Jansen stated that the problem can be solved if the DBE implements a plan where teachers are at the centre (UNESCO, 2024). With so many aspects of the South African education sector needing urgent attention, to focus on the teacher in the workplace is a manageable and achievable start. The DBE can monitor that all schools in SA have qualified teachers and monitor the work they are doing. As mentioned in 5.1.1 above, there are global guidelines for ensuring that teachers in the workplace contribute to a better education system.

6. Conclusion

Mathematics performance in secondary schools is of global concern and the systematic review of contributing factors in this paper was limited to analysing literature sources from the last ten years as found in Scopus. Valuable literature and insights were gained regarding trends in secondary school mathematics performance and the findings from the literature search assisted in answering the research questions. The findings also emphasise the lens from which this study is conducted as there is no linear relationship between trends and mathematics performance. From the findings above it is evident that, globally, the role of the teachers plays the most significant part in mathematics performance in secondary schools since the teacher is supposed to possess many of the skills and abilities required to succeed. These include subject knowledge and the capability to establish a growth mindset in learners. In order to build strong teacher capacity, teachers must be part of a professional learning community (PLC) to develop professionally. Furthermore, teachers must demonstrate a positive attitude in the classroom, especially in mathematics, since the subject is stereotyped as being a very difficult subject. In addition to all this, enjoyment, enthusiasm, and high expectations can also be regarded as skills and abilities that a teacher must have to contribute to mathematics performance. Another important aspect is that teachers must have a good relationship with their learners.

All these findings correlate with the characteristics described by Arends (2025), who stated that knowledge, professional development, and motivation are some of the aspects required. Therefore, the availability and standard of teaching and learning support were also found as contributing factors to mathematics performance. Support in terms of student-teacher relationships, resources, and learning environment was the most common contributing factor found in the literature. Many South African schools have these required factors in place but in schools where mathematics performance is lacking, the lessons drawn from the global context should be implemented to improve performance in mathematics.

7. Limitations and Recommendations

As with all research, this review also has its limitations. Only the Scopus database was used and only for a selected time window (i.e. the last ten years). This review was also conducted in secondary schools only and not in pre-primary or primary schools. However, despite these limitations, the findings are still valuable for secondary schools in South Africa. Further research can be done by consulting a wider database and surveying over a longer timeframe. It is also recommended that the contributing factors to mathematics performance in early childhood development be researched.

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