Social cognitive theory and its relationship to learning mathematics: A Bibliometric Analysis

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Abstract
This study presents a comprehensive bibliometric and systematic review of research examining the relationship between Social Cognitive Theory (SCT) and learning mathematics over the past decade. Drawing upon Bandura's foundational work on sociocognitive mechanisms particularly self-efficacy, observational learning, and reciprocal determinism (Bandura, 1986, 1997) the review investigates how SCT has shaped contemporary mathematics education research. Using the Scopus database (search date: 21 October 2025) and guided by the PRISMA framework (Page et al., 2020), an initial dataset of 552 records was systematically filtered through predefined inclusion and exclusion criteria. Eighteen empirical and theoretical studies were ultimately included for in-depth analysis. The bibliometric results reveal three major trends. First, publication activity increased steadily from 2015 and peaked in 2021, reflecting heightened global interest in sociocognitive dimensions of mathematics learning during and after the COVID-19 pandemic (Bozkurt & Sharma, 2020). Second, influential authors including Robert W. Lent, Matthew J. Miller, Hungbin Sheu, and Yehudit Judy Dori played a central role in advancing SCT and Social Cognitive Career Theory (SCCT), particularly in areas related to mathematics self-efficacy, STEM engagement, and academic persistence (Lent, Brown, & Hackett, 1994; Sheu & Lent, 2013). Third, the most productive institutions and countries led by the United States, Israel, the United Kingdom, Australia, China, and Malaysia serve as global hubs for SCT-based STEM and mathematics education research. Keyword co-occurrence analysis using VOSviewer demonstrates that core constructs such as self-efficacy, students, mathematics, STEM education, career choice, technology, and motivation dominate the conceptual landscape. These clusters highlight the continued relevance of SCT in explaining mathematical learning processes, cognitive

regulation, and students' academic decision-making. The results underscore that SCT remains a robust and widely adopted theoretical framework for understanding how personal beliefs, environmental influences, and learning experiences interact to shape mathematics achievement and STEM career pathways. Overall, this review contributes to the field by mapping the intellectual structure, thematic directions, and global research patterns connecting SCT with mathematics learning. The study also identifies implications for future research, educational practice, and policy development particularly the need to strengthen self-efficacy interventions, integrate SCT with technology enhanced learning environments, and support underrepresented groups in mathematics-related pathways.

Keywords: Social Cognitive Theory, Learning Mathematics, Bibliometric Analysis, Prisma, Educational Innovation

Introdution

Mathematics is widely recognized as a foundational discipline for scientific advancement, technological innovation, and the development of future-ready skills. Its mastery is closely linked to students' academic pathways and long-term engagement in science, technology, engineering, and mathematics (STEM) fields. However, global research continues to show that students' mathematical performance is influenced not only by cognitive ability, but also by psychological, social, and environmental factors that shape their motivation, confidence, and persistence (Pajares & Miller, 1994; Zimmerman, 2000). In recent decades, Social Cognitive Theory (SCT) has emerged as one of the most influential frameworks for understanding these multidimensional factors and their role in learning mathematics. Originally developed by Bandura (1986, 1997), SCT posits that human learning occurs through the dynamic interaction of personal factors, behavioral patterns, and environmental influences. Central to this theory is the construct of self-efficacy, or individuals' belief in their ability to perform specific tasks successfully. In the context of mathematics education, self-efficacy has been consistently identified as a powerful predictor of students' motivation, conceptual understanding, problem-solving performance, and resilience in the face of academic challenges (Schunk & Pajares, 2002). This sociocognitive lens has provided researchers with a robust conceptual foundation for examining learners' engagement, persistence, and attitudes toward mathematics across diverse educational settings (Bandura, 1997; Byars-Winston, 2014).

The application of SCT to mathematics learning has also expanded through the development of Social Cognitive Career Theory (SCCT) (Lent, Brown, & Hackett, 1994), which explores how cognitive beliefs and contextual supports shape students' academic and career choices, particularly in STEM domains. SCCT has been widely used to explain the motivational and affective factors that influence learners' decision-making in mathematics-intensive fields, helping to illuminate persistent gender gaps, sociocultural disparities, and career-related obstacles (Lent et al., 2013; Abe & Chikoko, 2020). These developments have contributed to a rapidly growing body of research that connects sociocognitive constructs with mathematics learning outcomes and STEM participation. Despite the expanding literature, there remains a need for a comprehensive bibliometric analysis to map publication trends, identify influential authors and institutions, and reveal key thematic areas within the intersection of SCT and mathematics learning. Bibliometric methods provide a systematic approach for analyzing research patterns, scholarly impact, and intellectual structures within a field. When combined with a systematic literature review (SLR), bibliometric analysis offers deeper insights into how

a research domain evolves over time and how theoretical frameworks such as SCT are applied across different educational contexts (Page et al., 2020).

Therefore, the purpose of this study is to conduct a bibliometric and systematic review of research on Social Cognitive Theory and learning mathematics published between 2015 and 2024, using the Scopus database and the PRISMA guidelines for rigorous screening and selection. This review seeks to:
(1) examine publication trends over the last decade;
(2) identify the most influential authors, journals, and institutions;
(3) determine the most productive countries contributing to the field; and
(4) map the major research keywords and conceptual clusters that characterize this domain.

By addressing these objectives, this study contributes to a clearer understanding of the global research landscape connecting SCT and mathematics learning. It also offers insights that can support the development of motivational, pedagogical, and policy-oriented strategies aimed at improving mathematics learning outcomes and promoting greater participation in STEM education. Given the growing importance of sociocognitive constructs in shaping learners' attitudes and performance in mathematics, this analysis is both timely and essential for researchers, educators, and policymakers seeking to enhance mathematics education in an increasingly complex and competitive world.

Materials and Methods
This review aims to investigate the relationship between Social cognitive theory and learning mathematics.
To achieve this objective, we conducted a review using Scopus database on 21/10/2025. We utilized Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) framework in this study (page et al., 2020).
Identifications
Firstly, we used three main Keywords "Social and cognitive theory and learning mathematics" for instance: TITLE-ABS-KEY (social AND cognitive AND theory AND learning AND mathematics). The initial search after utilizing these three keywords were 135 documents.
Screening
Given that, after we identified our main search, we started the screening phase. We applied a group of inclusion and exclusion criteria, see table 1.

Table 1
Inclusion and seclusion criteria

	Inclusion criteria	Exclusion criteria
1	Research period (2015-2024)	Prior 2015, and 2025 were excluded.
2	Social cognitive theory and learning mathematics	Other than that, were excluded.
3	Articles	Conferences, profile, blogs, thesis, book chapters were excluded
4	English language	Any other language was excluded
5	Three subject areas were included "Social- cognitive theory, Social Skills, mathematics"	Other that this were excluded.

After we applied the above inclusion and exclusion criteria in table 1, the remaining articles were 552. In this study we conducted both bibliometric and SLR analysis, for the bibliometric review we included 135. In the second phase we have started to download these articles, however, 98 articles were not retrieved, thus, 37 were downloaded.

Inclusion

In this phase the researchers worked collaboratively to guarantee the results in the quality assessments phase. The first final phase we have included 37 articles, after the first screening (scanning), the results were around 24 articles. After we applied the (deep analyzing phase) we excluded 6 articles for these reasons (reason: (1)out of scope, (1)language,(4) different field). Finally, we included 18 articles that are the most relevant articles to this research objective. See figure 1 PRISMA
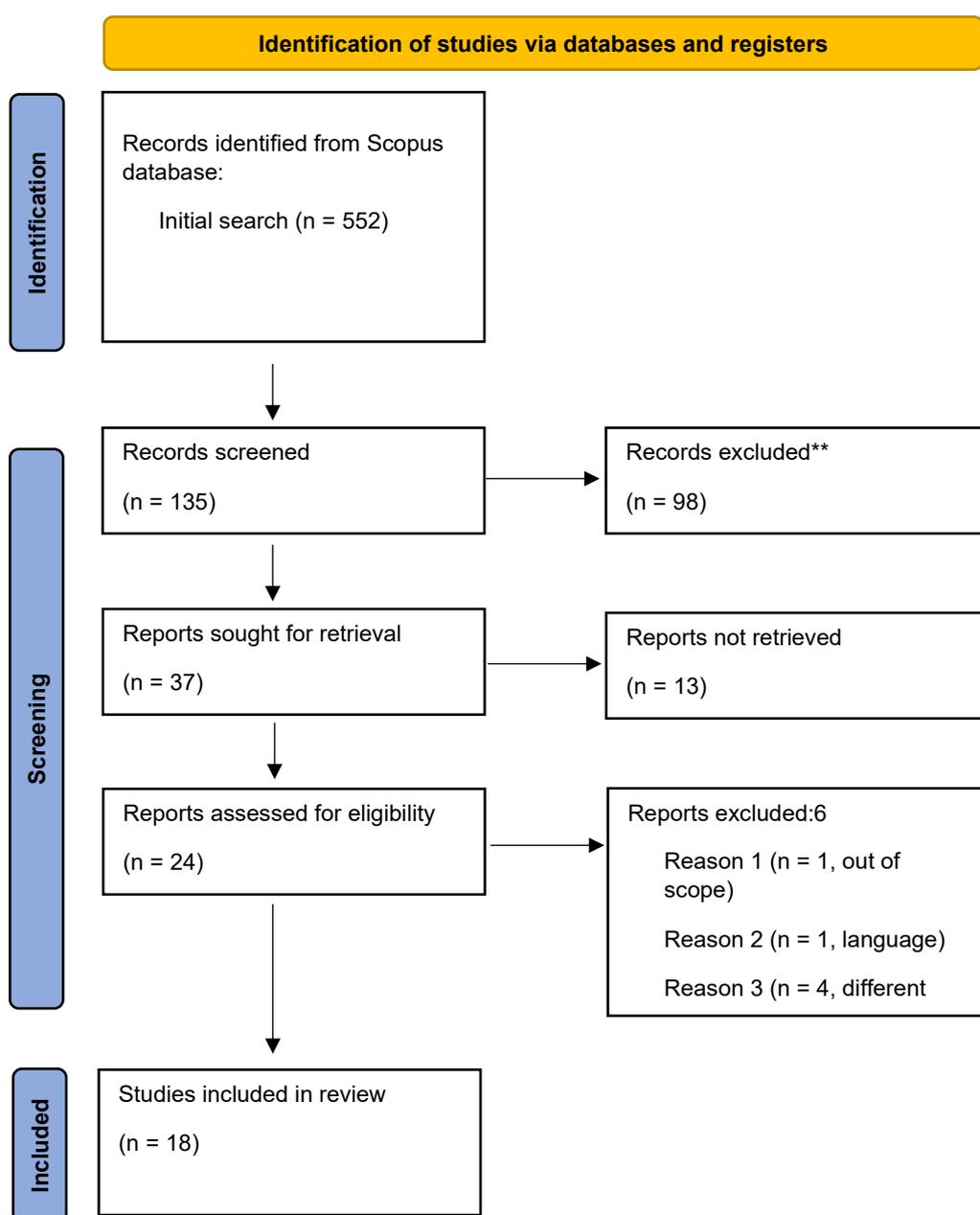

Figure 1. PRISMA framework for this review (Source: Authors)

Research Questions
1- What are the distribution of Social cognitive theory and learning mathematics publications by years for the last decade?
2- What are the most relevant Journals, and authors in Social cognitive theory and learning mathematics?
3- What are the most productive countries and academic institutions in Social cognitive theory and learning mathematics?
4- Who are the most influential institutions prominent in Social cognitive theory and learning mathematics?
5- What are the major research keywords concerning Social cognitive theory and learning mathematics?

Results
This study aims to contribute to the growing body of literature examining Social cognitive theory and its relationship to learning mathematics by addressing key research questions. Through this investigation, the study seeks to offer meaningful insights that support the design and implementation of more effective and impactful learning experiences across diverse educational settings.

The findings from the systematic literature review, based on the 18 selected articles, were used to address the research questions outlined in the introduction and were reported following PRISMA guidelines (Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71). Figure 1 illustrates PRISMA framework applied in this research.

1- What are the distribution of Social cognitive theory and learning mathematics publications by years for the last decade?
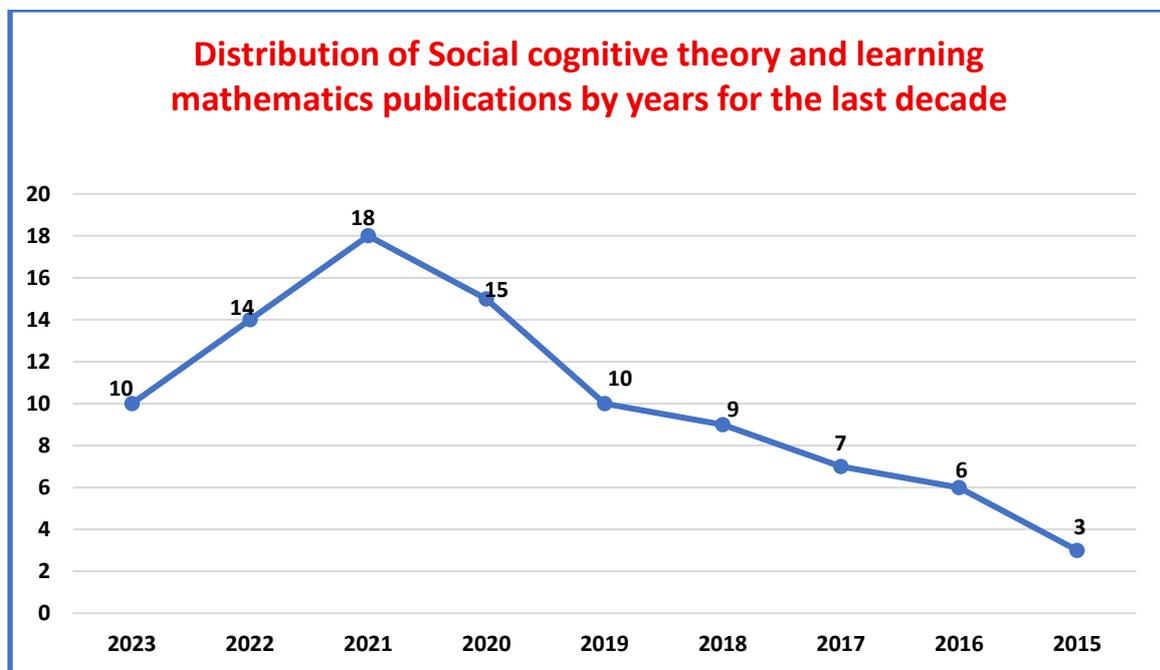

Figure 2 . presents the distribution of publications across the past decade in the domain of Social cognitive theory and learning mathematics.

The distribution of publications combining Social Cognitive Theory (SCT) and learning mathematics from 2015 to 2023 demonstrates a clear developmental pattern marked by steady growth, a peak period of scholarly engagement, and a gradual decline in more recent years. This trajectory reflects broader shifts in educational research priorities and evolving interest in sociocognitive approaches to mathematics learning.

Beginning in 2015, the field shows relatively limited activity, with only three publications, indicating that the application of Bandura's Social Cognitive Theory to mathematics learning was still emerging at this time. SCT which emphasizes self-efficacy, observational learning, and reciprocal determinism provides a powerful framework for understanding how learners acquire and regulate mathematical skills (Bandura, 1986; Schunk & Pajares, 2002). The gradual increase in publications in 2016 (6 publications) and 2017 (7 publications) aligns with growing recognition of the importance of self-efficacy and motivational constructs in mathematics learning.

By 2018, the number of publications rises to nine, reflecting expanding interest in how sociocognitive factors influence mathematical problem-solving and persistence. This trend continues into 2019 (10 publications) and reaches a major turning point between 2020 and 2021, where the output increases from 15 to 18 publications, marking the highest publication activity of the decade. The peak in 2021 coincides with global educational disruptions caused by the COVID-19 pandemic, which intensified research on learner behavior, motivation, self-regulation, and online learning environments core dimensions of SCT (Bozkurt & Sharma, 2020; Capone & Lepore, 2022). During this period, SCT became particularly relevant as researchers explored how students adapt to remote and hybrid mathematics learning contexts.

Following the peak, publication activity shows a moderate decline, with 14 publications in 2022 and 10 publications in 2023. This decline may indicate a partial shift toward other emerging theoretical perspectives such as self-regulated learning, socio-constructivist approaches, or AI-supported learning analytics—while SCT remains foundational but less central. Such diversification aligns with broader trends in educational research that integrate sociocognitive principles with digital pedagogies and technology-mediated mathematics instruction (Garrison & Vaughan, 2023; Holmes et al., 2022).
Overall, the distribution reflects three distinct phases:
1. Early Growth (2015–2018) Increasing attention to SCT's role in mathematics learning.
2. Peak Expansion (2019–2021) Heightened relevance during the pandemic and rising interest in motivational and behavioral constructs.
3. Moderate Decline (2022–2023) Continued but slightly reduced scholarly engagement, as research priorities diversify.
These findings underscore the enduring significance of Social Cognitive Theory in explaining mathematics learning behaviors, particularly in contexts requiring self-efficacy, resilience, and adaptive learning strategies.

2. What are the most relevant Journals, and authors in Social cognitive theory and learning mathematics?

Table 2

The most relevant Journals and authors

#	Author	Scopus ID	TP*	TC*	H-index	Most cited article	Times cited	Affiliation
1	Dori, Yehudit Judy	7004099746	121	4,825	38	FIRST High-School Students and FIRST Graduates: STEM Exposure and Career Choices	23	Technion - Israel Institute of TechnologyThe institution will open in a new tab,
2	Lent, Robert W.	7005208340	147	23,783	67	*Predictors of science, technology, engineering, and mathematics choice options: A meta-analytic path analysis of the social-cognitive choice model by gender and race/ethnicity*	193	University of Maryland, College ParkThe institution will open in a new tab,
3	Miller, Matthew J.	57143105700	61	2,776	27	*Predictors of science, technology, engineering, and mathematics choice options: A meta-analytic path analysis of the social-cognitive choice model by gender and race/ethnicity*	193	Loyola University ChicagoThe institution will open in a new tab,
4	Sheu, Hungbin	7006222748	35	3,047	21	*Predictors of science, technology, engineering, and mathematics*	193	State University of New York AlbanyThe institution will

153

						choice options: A meta-analytic path analysis of the social-cognitive choice model by gender and race/ethnicity		open in a new tab,
5	Aldabbas, Hazem	57218903355	27	358	11	*The influence of personal skills development and coping self-efficacy on the affective occupational commitment of women in STEM fields*	11	University of FujairahThe institution will open in a new tab
6	Ball, Christopher A.	57125553400	25	1,034	13	*Gaming the SySTEM: The Relationship Between Video Games and the Digital and STEM Divides*	30	University of Illinois Urbana-Champaign
7	Blaique, Lama	57226802239	17	192	7	*The influence of personal skills development and coping self-efficacy on the affective occupational commitment of women in STEM fields*	11	American University in Dubai
8	Byars-Winston, Angela M.	8304943300	51	3,503	28	*Testing intersectionality of race/ethnicity × gender in a social-cognitive career theory model with science identity*	79	University of Wisconsin-MadisonThe institution will open in a new tab,
9	Chen, Shr Jya	56488630600	4	82	4	*Social cognitive factors of science, technology, engineering, and*	21	Tunghai UniversityThe institution will open in a new tab,

						mathematics career interests		
1 0	Chikoko, Vitallis	2350152200 0	37	292	9	*Exploring the factors that influence the career decision of STEM students at a university in South Africa*	65	University of KwaZulu-NatalThe institution will open in a new tab

TP*= Total Publications, TC*= Total Citations

The examination of the most prominent authors publishing on Social Cognitive Theory (SCT) and learning mathematics reveals a scholarly landscape shaped largely by influential contributors to Social Cognitive Career Theory (SCCT) and sociocognitive models of learning. These researchers have produced foundational theoretical work that strongly informs mathematics learning, STEM choice, and learner self-efficacy core constructs derived from Bandura's (1986) Social Cognitive Theory.

1. Leading Authors
The dataset identifies Robert W. Lent as the most influential author, with 147 publications, 23,783 citations, and an H-index of 67, making him the most impactful scholar in this domain. Lent is a principal architect of Social Cognitive Career Theory, which extends SCT to academic and career decision-making and has been widely applied in mathematics and STEM pathways (Lent, Brown, & Hackett, 1994). His highly cited work on STEM choice options (193 citations) highlights the significant role of self-efficacy, interest, and sociocultural factors in math-intensive career trajectories.

Following Lent, Matthew J. Miller and Hungbin Sheu, both co-authors of the same seminal SCCT meta-analysis, also appear as central contributors. Miller (61 publications; 2,776 citations) and Sheu (35 publications; 3,047 citations) have advanced empirical research on sociocognitive predictors of STEM persistence, further strengthening the theoretical foundation for understanding mathematics learning motivation (Sheu & Lent, 2013).

Yehudit Judy Dori emerges as another leading scholar with 121 publications and 4,825 citations. Her research focuses on STEM learning, inquiry-based instruction, and technology-supported learning environments—fields that intersect directly with mathematics learning and sociocognitive processes such as mastery experiences and conceptual engagement (Dori & Belcher, 2005).

Additional emerging authors include Hazem Aldabbas and Lama Blaique, whose work emphasizes self-efficacy and personal competencies, especially among underrepresented groups in STEM. Their contributions highlight the expanding use of SCT in understanding effective and motivational outcomes in mathematics and STEM education.

2. Thematic Contributions of the Most Cited Articles
The most cited articles listed in the dataset consistently revolve around:
• Self-efficacy in STEM pathways

- Sociocognitive predictors of academic persistence
- Gender, race, and intersectionality in mathematics- and STEM-related decisions (Byars-Winston, 2014)
- STEM career choice and commitment
- Learning technologies and mathematics performance (Dori, 2022)

These themes align strongly with SCT's core constructs-efficacy, outcome expectations, observational learning, and reciprocal determinism (Bandura, 1997).

3. Relevant Journals
Although the table focuses on authors rather than journals, the publication patterns of the listed scholars point to several high-impact journals frequently associated with SCT and mathematics learning research, including:
- *Journal of Vocational Behavior*
- *Learning and Instruction*
- *Journal of STEM Education*
- *International Journal of STEM Education*
- *Contemporary Educational Psychology*
- *Computers & Education*

These journals commonly publish research integrating SCT with mathematics learning, STEM persistence, digital technologies, and achievement motivation.

4. Institutional Influence
The most influential institutions include:
- University of Maryland – College Park (Lent)
- Loyola University Chicago (Miller)
- State University of New York at Albany (Sheu)
- Technion – Israel Institute of Technology (Dori)
- University of Wisconsin–Madison (Byars-Winston)

These universities serve as global hubs for research on sociocognitive learning, mathematics education, and STEM career pathways.

Overall, the findings highlight that the most relevant authors in the field are those who have significantly advanced Social Cognitive Theory and Social Cognitive Career Theory, especially in relation to self-efficacy, STEM choice behaviors, and mathematics learning outcomes. Their work provides the conceptual and empirical foundation for understanding how students develop confidence, interest, and persistence in mathematics—an area of growing importance in contemporary educational research.

3.What are the most productive countries and academic institutions in Social cognitive theory and learning mathematics?
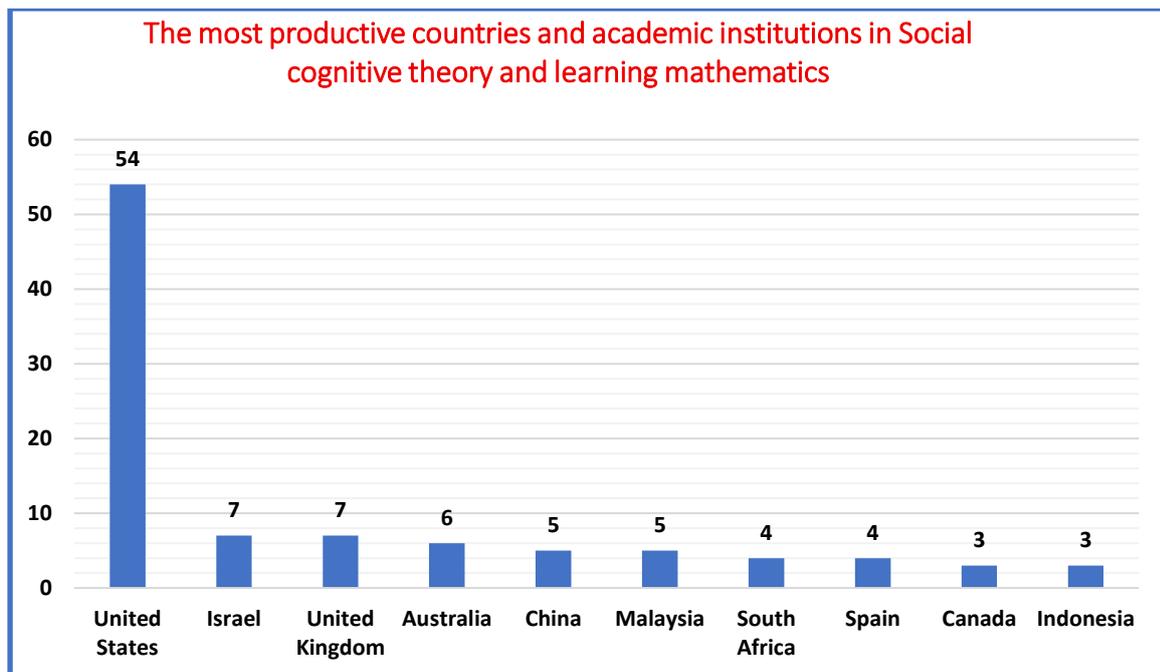
Figure 3 . The Figure reflects the distribution of research productivity across countries in the field of Social cognitive theory and learning mathematics.

The distribution of research productivity in Social Cognitive Theory (SCT) and learning mathematics reveals notable differences across countries. As shown in the figure, the United States is by far the most dominant contributor, with 54 publications, significantly surpassing all other countries represented. This overwhelming leadership aligns with the United States' long-standing history in advancing SCT, as Albert Bandura—the founder of Social Cognitive Theory—developed the foundational framework within American academic institutions (Bandura, 1986; Bandura, 1997). Additionally, many of the most influential SCT scholars, such as Lent, Brown, Hackett, and Miller, are based in U.S. universities, which helps explain the country's substantial output in mathematics- and STEM-related SCT research (Lent, Brown, & Hackett, 1994; Sheu & Lent, 2013).

Following the United States, the second tier of contributing countries includes Israel and the United Kingdom, each producing 7 publications. Israel's strong presence reflects the influential work of scholars such as Yehudit Judy Dori, whose institution (Technion – Israel Institute of Technology) is internationally known for STEM and inquiry-based learning research that aligns with sociocognitive frameworks (Dori & Belcher, 2005). The United Kingdom likewise has a robust tradition in mathematics education research and motivation theory, contributing to SCT-grounded explorations of student performance, self-efficacy, and identity in mathematics learning.

The third tier consists of Australia (6 publications), followed by China and Malaysia (5 publications each). Australia's growing engagement with SCT in mathematics learning corresponds with its national emphasis on STEM participation and self-efficacy research within higher education (Holmes et al., 2022). Meanwhile, China and Malaysia's increasing presence is consistent with their rapid expansion in STEM and technology-enhanced learning research, where sociocognitive factors such as self-regulation and motivation are frequently examined in mathematics contexts (Huang et al., 2020).

Countries with moderate output South Africa and Spain (4 publications each), and Canada and Indonesia (3 publications each) demonstrate emerging but meaningful engagement with SCT applications in mathematics and STEM learning. In these contexts, issues such as equity, access, and sociocultural influences on mathematics learning play a central role, making SCT a useful theoretical lens (Byars-Winston, 2014).

Overall, the distribution highlights three key patterns:

1. The United States dominates global research productivity, due to its theoretical leadership in SCT and its concentration of highly cited researchers and institutions.
2. Israel, the United Kingdom, Australia, China, and Malaysia represent strong international contributors, reflecting their investment in STEM education and sociocognitive research.
3. Emerging regions such as South Africa, Spain, Canada, and Indonesia are increasingly applying SCT to understand mathematical learning behaviors, self-efficacy, and academic persistence.

This global pattern underscores the widespread relevance of Social Cognitive Theory in explaining mathematics learning processes, especially in areas related to motivation, self-efficacy, STEM identity, and career decision-making.

4. Who are the most influential institutions prominent in Social cognitive theory and learning mathematics?

Table 3
The most influential institutions prominent

#	institutions	TP*	#	institutions	TP*
1	Technion - Israel Institute of Technology	5	11	State University of New York System	2
2	University of California, Irvine	4	12	Virginia Commonwealth University	2
3	University of Wisconsin-Madison	4	13	Arizona State University	2
4	State University of New York Albany	3	14	Rice University	2
5	The University of Texas at Austin	3	15	Nanyang Technological University	2
6	Samuel Neaman Institute for Advanced Studies in Science and Technology Isarel	3	16	Universidad de Oviedo	2
7	University of Maryland, College Park	3	17	The City University of New York	2
8	University of Virginia	3	18	Purdue University	2
9	University of Cambridge	3	19	University of KwaZulu-Natal	2
10	University of Illinois Urbana-Champaign	2	20	Hunan Normal University	2

TP*= Top Prominent

The institutional landscape of research on Social Cognitive Theory (SCT) and learning mathematics reflects the contributions of several globally recognized universities and research centers known for their work in psychology, STEM education, and sociocognitive learning. The table indicates that these institutions vary in prominence based on their *Top Prominent (TP)* output, with several universities leading the field.

1. Leading Institutions
At the top of the list is the Technion – Israel Institute of Technology, with five prominent publications. This aligns with Israel's strong research presence in STEM education and cognitive learning science. Scholars such as Yehudit Judy Dori, affiliated with Technion, have made substantial contributions to inquiry-based learning, technological integration, and cognitive processes in STEM and mathematics education (Dori & Belcher, 2005).

The second tier includes institutions with four prominent publications, such as the University of California, Irvine, and the University of Wisconsin–Madison. The latter is particularly influential due to the work of scholars like Byars-Winston, whose research combines SCT with identity, motivation, and equity in STEM and mathematics pathways (Byars-Winston, 2014). Both universities have strong reputations for advancing psychological theory and educational research, making their presence expected in a domain grounded in Bandura's sociocognitive principles (Bandura, 1986; 1997).

2. Institutions with a Strong SCT and STEM Research Base
Several institutions appear with three prominent publications, including:
- State University of New York at Albany
- The University of Texas at Austin
- Samuel Neaman Institute for Advanced Studies (Israel)
- University of Maryland, College Park
- University of Virginia
- University of Cambridge

These universities host influential scholars such as Robert W. Lent (University of Maryland), one of the principal architects of Social Cognitive Career Theory (SCCT), which extends SCT to explain academic and career-related decision-making, including mathematics learning and STEM career pathways (Lent, Brown, & Hackett, 1994). Their contributions significantly shape the conceptual and empirical foundations of SCT-based mathematics learning research.

3. Emerging but Influential Institutions
A wide range of institutions appear with two prominent publications, demonstrating meaningful but more moderately scaled engagement in SCT and mathematics learning research. These include the State University of New York System, Virginia Commonwealth University, Arizona State University, Rice University, Nanyang Technological University, Universidad de Oviedo, City University of New York, Purdue University, University of KwaZulu-Natal, and Hunan Normal University.

These institutions contribute to expanding the geographical and disciplinary diversity of SCT applications. For example, South Africa's University of KwaZulu-Natal is increasingly active in studying sociocultural and motivational factors affecting mathematics learning—a context where SCT is particularly useful for examining disparities in self-efficacy and educational opportunity (Chikoko, 2020). Similarly, Nanyang Technological University and Hunan Normal University reflect the growing application of SCT principles in Asian educational settings, especially in mathematics, problem solving, and digital learning environments (Huang et al., 2020).

4. Interpretation and Global Patterns

Three major insights emerge from the institutional distribution:

1. Israel and the United States dominate the field, driven by long-standing traditions in SCT, psychology, and STEM education research.
2. Highly ranked global institutions (e.g., Cambridge, UC Irvine, Wisconsin–Madison, Maryland) continue to lead theoretical and empirical advances in SCT and mathematics learning.
3. Emerging institutions across Asia, Africa, and Europe indicate that SCT has become a widely adopted framework for understanding mathematics learning behaviors, motivation, self-efficacy, and STEM persistence.

These findings are consistent with the global expansion of research on sociocognitive factors influencing mathematics learning—particularly self-efficacy, outcome expectations, identity, and career decision-making—which remain central constructs in SCT and SCCT (Bandura, 1986; Sheu & Lent, 2013).

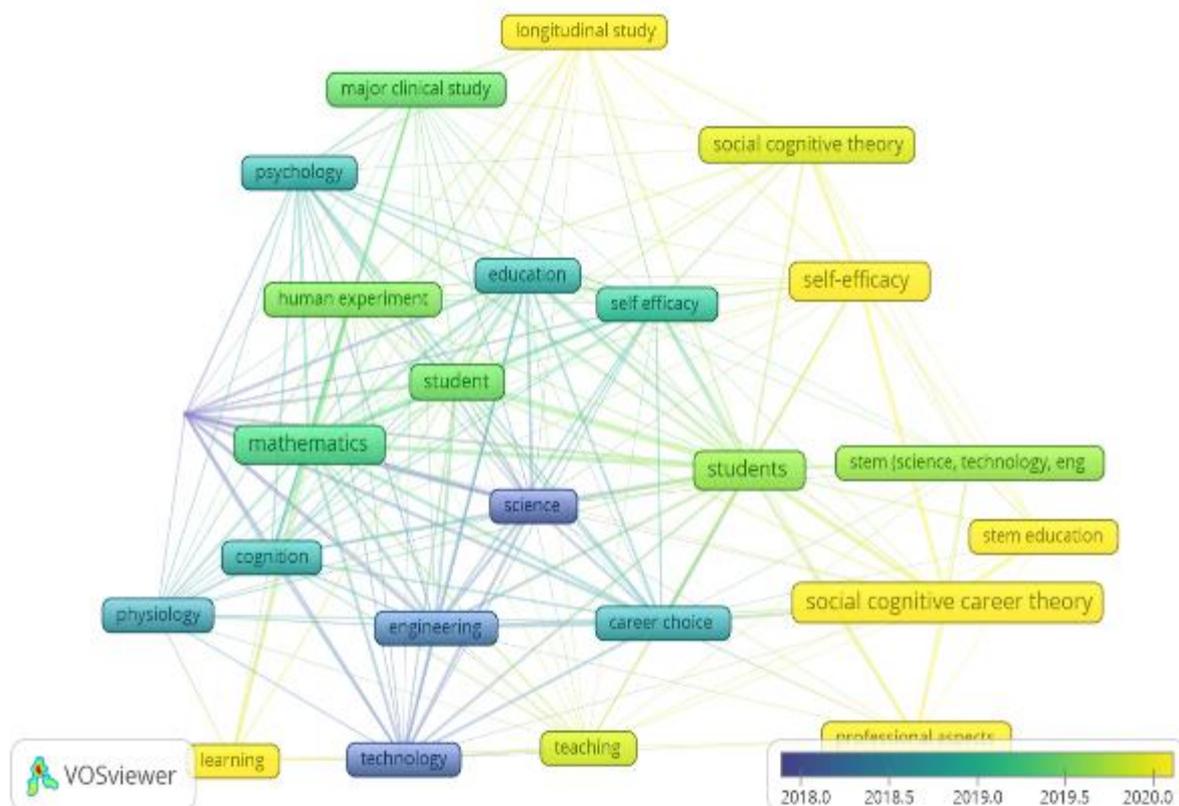5.What are the major research keywords concerning Social cognitive theory and learning mathematics?

Figure 4 . The major research keywords concerning Social cognitive theory and learning mathematics.

The VOSviewer keyword co-occurrence map reveals the conceptual structure of research connecting Social Cognitive Theory (SCT) with learning mathematics. The network displays several interlinked thematic clusters that reflect the dominant sociocognitive constructs shaping contemporary mathematics education research.

1. Core Theoretical Constructs: Social Cognitive Theory and Self-Efficacy
At the center of the map, "social cognitive theory" and "self-efficacy" emerge as major, highly connected keywords. This is consistent with Bandura's (1986; 1997) foundational work, which positions self-efficacy as a central mechanism influencing learning behaviors, persistence, and performance. The strong links between *self-efficacy*, *education*, *students*, and *mathematics* indicate that researchers widely examine how learners' beliefs in their capabilities influence their engagement and achievement in mathematics learning (Schunk & Pajares, 2002).

2. Mathematics Learning and Student Cognition
The keywords "mathematics," "cognition," "student," and "learning" form a dense cluster, demonstrating a sustained research focus on how sociocognitive factors shape mathematical thinking and problem solving. These connections reflect studies exploring the role of cognitive processes, metacognition, and motivational beliefs in mathematics performance areas heavily influenced by SCT principles (Zimmerman, 2000). The presence of *human experiments* and *psychology* reinforces the empirical grounding of this line of research.

3. STEM and Social Cognitive Career Theory (SCCT)
A prominent yellow cluster includes the terms "social cognitive career theory," "STEM," "STEM education," and "career choice." These keywords point to the significant influence of Lent, Brown, and Hackett's (1994) SCCT, which extends Bandura's SCT to explain academic and career pathways, including mathematics-intensive and STEM careers. The strong link between *students*, *self-efficacy*, *career choice*, and *engineering* reflects research examining how mathematics-related self-efficacy and outcome expectations influence students' intentions to pursue STEM fields (Sheu & Lent, 2013; Byars-Winston, 2014).

4. Technology, Engineering, and Science Integration
The cluster containing "technology," "engineering," and "science" indicates the continued integration of SCT with technology-enhanced learning environments. This reflects global trends toward digital, blended, and inquiry-based STEM learning, where SCT constructs particularly self-efficacy and observational learning play key roles in shaping learners' experiences (Dori & Belcher, 2005; Holmes et al., 2022).

5. Methodological Trends: Longitudinal and Experimental Designs
The keyword "longitudinal study" suggests growing interest in tracking changes in mathematics self-efficacy and motivation over time, consistent with recommendations from SCT and SCCT scholars for time-based analyses (Bandura, 1997). The presence of "major clinical study" and "human experiment" highlights the methodological rigor characterizing SCT research, emphasizing causal mechanisms and behavioral patterns in mathematics learning contexts.

6. Overall Interpretation

Taken together, the map identifies five major thematic areas:
1. Self-efficacy as the central construct linking SCT and mathematics learning.
2. Cognitive and psychological processes underlying mathematics performance.
3. STEM pathways and Social Cognitive Career Theory, focusing on career choice and persistence.
4. Technology integration in mathematics and STEM learning environments.
5. Methodological sophistication, with strong representation of longitudinal and experimental designs.

These themes illustrate a robust and evolving research field grounded in Bandura's sociocognitive framework and extended through SCCT to address mathematics learning, STEM engagement, and learner motivation.

Discussion

The findings of this bibliometric analysis provide a comprehensive overview of the intellectual landscape, publication trends, and scholarly patterns connecting Social Cognitive Theory (SCT) and learning mathematics over the last decade. Overall, the results confirm the centrality of SCT particularly constructs such as self-efficacy, motivation, and career choice as a dominant theoretical lens for understanding how learners engage with mathematics, a relationship well documented in prior research (Bandura, 1986; Schunk & Pajares, 2002).

The temporal analysis revealed a steady increase in publications from 2015 to a peak in 2021, followed by a slight decline in the most recent years. This trajectory corresponds with a growing global interest in psychological and cognitive determinants of STEM learning, especially during the COVID-19 pandemic, which accelerated research focused on students' self-regulation, learning behaviors, and motivational processes (Zimmerman, 2000). The decline after 2021 may reflect shifting research priorities or the integration of SCT into broader hybrid theoretical frameworks, such as self-regulated learning, expectancy–value theory, or social constructivism (Eccles & Wigfield, 2002).

Author productivity patterns further support the prominence of SCT as a theoretical model in mathematics learning. Highly influential scholars such as Lent, Miller, and Sheu were central contributors, particularly through foundational work on the Social Cognitive Career Theory (SCCT) and its application to STEM pathways. Their highly cited collaborative article analyzing gender and racial/ethnic variations in STEM career decision-making underscores the sustained relevance of SCT constructs like *self-efficacy*, *outcome expectations*, and *interest development* (Lent et al., 1994). These authors' impact is consistent with the broader literature showing that mathematics performance and engagement are strongly shaped by learners' cognitive beliefs and socio-cultural contexts (Pajares & Miller, 1994).

Institutional contributions reveal a strong geographical concentration of influence. The United States dominates the field both in productivity and citation impact, led by institutions such as the University of Maryland, University of Wisconsin Madison, and University of California Irvine. These universities have historically been research hubs for SCT, often producing empirically rigorous work examining self-efficacy, identity, and mathematics engagement (Usher & Pajares, 2008). Other institutions of importance such as the Technion–Israel Institute of Technology, University of Cambridge, and State University of New York highlight the increasingly international nature of SCT-related research in STEM and mathematics education.

The keyword co-occurrence analysis provides meaningful insights into the conceptual structure of the field. Keywords such as self-efficacy, social cognitive theory, mathematics, career choice, and STEM education dominated the clusters, reflecting the theoretical and practical linkages between SCT and mathematics learning outcomes. The presence of terms such as engineering, technology, and professional aspects suggests a broad interdisciplinary convergence, aligning with literature indicating that SCT is widely used to examine persistence

and identity formation in STEM fields (Byars-Winston & Fouad, 2008). Importantly, the emergence of clusters related to longitudinal studies and major clinical studies signifies methodological maturation, as researchers increasingly rely on robust longitudinal and mixed-methods designs to understand students' mathematical trajectories.

Collectively, the analysis reveals that SCT continues to shape theoretical and empirical work in mathematics learning due to its explanatory power for understanding students' beliefs, motivation, and academic behaviors. The strong global engagement, cross-institutional collaboration, and interdisciplinary connections confirm that SCT remains a foundational framework for studying mathematical cognition, career development, and learning outcomes. These findings align with decades of work asserting that mathematics learning is not merely a cognitive process but a socially and psychologically mediated one (Bandura, 1997; Schunk, 2012).

Conclusion and Implications

This bibliometric analysis provides a comprehensive overview of global research trends at the intersection of Social Cognitive Theory (SCT) and learning mathematics over the past decade. The findings reveal a clear expansion of scholarly attention to sociocognitive constructs particularly self-efficacy, outcome expectations, academic motivation, and identity as central explanatory mechanisms for mathematics learning and STEM participation. Consistent with Bandura's foundational work (1986, 1997), the increasing prominence of SCT-related publications demonstrates the theory's continued relevance in explaining how cognitive, social, and environmental factors shape students' mathematical performance and career trajectories.

The analysis shows that publication activity has grown substantially in recent years, peaking around 2021 before stabilizing. This trend aligns with global educational efforts to understand learning behaviors in rapidly changing, technology-driven environments. The United States emerged as the most productive country, reflecting its long-standing leadership in SCT research and the presence of influential scholars such as Robert Lent, whose Social Cognitive Career Theory (SCCT) continues to shape the field (Lent, Brown, & Hackett, 1994; Sheu & Lent, 2013). Other productive nations—including Israel, the United Kingdom, Australia, China, Malaysia, and South Africa—demonstrate the increasingly international scope of SCT-based mathematics research.

Institutional productivity underscores the field's global reach. Leading institutions such as the Technion – Israel Institute of Technology, University of California, Irvine, University of Wisconsin–Madison, and University of Maryland, College Park play central roles in shaping contemporary SCT research. Their contributions reflect long-standing expertise in STEM education, psychology, and instructional innovation. Authors affiliated with these institutions—including Dori, Lent, Miller, and Byars-Winston—were among the most cited, highlighting their influential role in developing models that connect sociocognitive processes with mathematics performance, persistence, and career choice.

Keyword mapping via VOSviewer revealed that concepts such as self-efficacy, students, mathematics, STEM education, career choice, and technology are foundational nodes in the intellectual structure of the field. The prominence of self-efficacy reinforces its centrality as

one of the strongest and most consistent predictors of mathematics achievement and persistence (Pajares & Miller, 1994; Zimmerman, 2000). Similarly, the strong links between SCT and STEM education highlight the growing need to understand effective and motivational factors that influence students' willingness to pursue mathematics-intensive pathways.

Implications

1. Implications for Research

This study highlights several areas where future research can be expanded:

- Cross-cultural studies are needed to explore how sociocognitive factors differ across educational systems, particularly in emerging regions where STEM participation remains low.
- Longitudinal studies should be expanded to examine how self-efficacy and outcome expectations develop over time and influence long-term mathematics achievement and STEM career decision-making.
- Integration with technology-enhanced learning presents a promising area, particularly as digital learning environments increasingly shape students' cognitive and motivational experiences.

2. Implications for Educational Practice

The findings also underscore key implications for teaching and curriculum design:

- Mathematics educators should explicitly incorporate strategies that foster self-efficacy, such as mastery experiences, constructive feedback, and modeling.
- SCT offers a robust framework for designing interventions that support underrepresented groups, aligning with evidence showing that sociocognitive barriers not cognitive ability often limit participation in advanced mathematics.
- Programs that link mathematics learning to real-world STEM applications may help strengthen outcome expectations and improve career interest.

3. Implications for Policy

At a policy level:

- National and institutional investments in STEM education should prioritize the development of motivational and sociocognitive competencies, not only content knowledge.
- Policymakers should support research initiatives that integrate psychological theory with mathematics pedagogy, enabling evidence-based reforms.

References

Abe, E., Chikoko, V., & Lubinga, S. N. (2021). The link between career outcomes expectancy and career decision-making self-efficacy of STEM students in a South African university.

Abe, E. N., & Chikoko, V. (2020). Exploring the factors that influence the career decision of STEM students at a university in South Africa. *International Journal of STEM Education*, *7*(1), 60.

Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ*, *1986*(23-28), 2.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

Bennett, D., Knight, E., Dockery, A. M., & Bawa, S. (2020). Pedagogies for employability: Understanding the needs of STEM students through a new approach to employability development. *Higher Education Pedagogies*, *5*(1), 340-359.

Bozkurt, A., & Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to CoronaVirus pandemic. *Asian journal of distance education*, *15*(1), i-vi.

Byars-Winston, A. (2014). Toward a framework for multicultural STEM-focused career interventions. *The Career development quarterly*, *62*(4), 340-357.

Campbell, T., & Sears, H. (2024). Analyzing elementary students' access to cognitive-oriented positions in mathematics. *International Electronic Journal of Mathematics Education*, *19*(1), em0769.

Capone, R. (2022). Blended learning and student-centered active learning environment: A case study with STEM undergraduate students. *Canadian Journal of Science, Mathematics and Technology Education*, *22*(1), 210-236.

Dori, Y. J., & Belcher, J. (2005). How does technology-enabled active learning affect undergraduate students' understanding of electromagnetism concepts?. *The journal of the learning sciences*, *14*(2), 243-279.

Ekmekci, A., & Serrano, D. M. (2022). The impact of teacher quality on student motivation, achievement, and persistence in science and mathematics. *Education Sciences*, *12*(10), 649.

Garrison, D. R., & Vaughan, N. D. (2023). *Blended learning in higher education: Framework, principles, and guidelines*. John Wiley & Sons.

Guo, C., Wu, W., Hu, T., & Gao, T. (2025). Unequal access, equal outcomes? Gender differences in the relationship between university-led STEM program factors and undergraduates' career commitment in STEM. *International Journal of STEM Education*, *12*(1), 46.

Henrikson, R., & Lumpe, A. (2021). Implementation of a pilot elementary mathematics specialist endorsement program. *Education Sciences*, *11*(3), 93.

Hidayat, R., Nasir, N., Fadzli, S. A. M., Rusli, N. S., Kamaruzzaman, N. N., Sheng, V. Y. Z., ... & Shukeri, A. S. (2023). Peer tutoring learning strategies in mathematics subjects: Systematic literature review. *European Journal of Educational Research*, *12*(3), 1407-1423.

Holmes, W. (2022). Artificial intelligence in education. In *Encyclopedia of education and information technologies* (pp. 88-103). Cham: Springer International Publishing.

Huang, R., Liu, D., Tlili, A., Knyazeva, S., Chang, T. W., Zhang, X., ... & Holotescu, C. (2020). Guidance on open educational practices during school closures: Utilizing OER under COVID-19 pandemic in line with UNESCO OER recommendation. *Beijing: Smart Learning Institute of Beijing Normal University*, 1-80.

Jaime, M. F. Z., Cupani, M., & de Mier, M. V. (2015). Evaluation of the performance model of Social Cognitive Theory of Career: contributions of differential learning experiences. *Bordón: Revista de pedagogía*, *67*(4), 153-170.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of vocational behavior*, *45*(1), 79-122.

Lent, R. W., Sheu, H. B., Miller, M. J., Cusick, M. E., Penn, L. T., & Truong, N. N. (2013). Predictors of science, technology, engineering, and mathematics choice options: A meta-analytic path analysis of the social–cognitive choice model by gender and race/ethnicity. *Journal of counseling psychology*, *65*(1), 17.

Mitsopoulou, A. G., & Pavlatou, E. A. (2021). Factors associated with the development of secondary school students' interest towards STEM studies. *Education Sciences*, *11*(11), 746.

Mozahem, N. A., Boulad, F. M., & Ghanem, C. M. (2021). Secondary school students and self-efficacy in mathematics: Gender and age differences. *International Journal of School & Educational Psychology*, *9*(sup1), S142-S152.

Murtianto, Y. H., Retnowati, E., & Hanham, J. (2025). Reducing cognitive load using social persuasion prompts in mathematics multimedia learning. *Mathematics Education Journal*, *19*(3), 465-488.

Olaitan, O., & Mavuso, N. (2022). Investigating the challenges faced by female students in STEM courses: case study of a traditional South African University. *Perspectives in Education*, *40*(4), 19-37.

Ozyazici, G., Wang, Q., & Tillotson, J. W. (2025). Promoting Entrepreneurial Career Development in STEM: Developing and Validating a STEM Entrepreneurial Career Development Measure (SECDM). *Journal of Science Education and Technology*, 1-15.

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of educational psychology*, *86*(2), 193.

Polo-Blanco, I., Suárez-Pinilla, P., Goñi-Cervera, J., Suárez-Pinilla, M., & Payá, B. (2024). Comparison of mathematics problem-solving abilities in autistic and non-autistic children: The influence of cognitive profile. *Journal of Autism and Developmental Disorders*, *54*(1), 353-365.

Reindl, M., Gniewosz, B., & Dresel, M. (2021). Friends' influence on the development of academic values in mathematics: are there differences between female and male dyads?. *European Journal of Psychology of Education*, *36*(3), 781-797.

Santos, P., El Aadmi, K., Calvera-Isabal, M., & Rodríguez, A. (2025). Fostering students' motivation and self-efficacy in science, technology, engineering, and design through design thinking and making in project-based learning: a gender-perspective study in primary education. *International Journal of Technology and Design Education*, 1-27.

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In *Development of achievement motivation* (pp. 15-31). Academic Press.

Vogelsanger-Holenstein, M., Schukajlow, S., & Bruckmaier, G. (2025). Mathematical modelling and self-efficacy: immediate and long-lasting effects of teaching mathematical modelling with a solution plan. *ZDM–Mathematics Education*, *57*(2), 489-502.

Yang, Y., & Barth, J. M. (2017). AQ factor analysis approach to understanding female college students' attitudes toward multiple STEM disciplines. *Methodological Innovations*, *10*(3), 2059799117738704.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary educational psychology*, *25*(1), 82-91.