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ВИВЧЕННЯ ЗМІСТУ МАТЕМАТИКИ В КОНТЕКСТІ ПРОФЕСІЙНО-ТЕХНІЧНОЇ ОСВІТИ: СИСТЕМАТИЧНИЙ ОГЛЯД

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АНОТАЦІЯ

Формулювання проблеми. *Математика має фундаментальне значення для професійно-технічної освіти (ПТО). Це пов'язано з тим, що математика дозволяє учням закладів ПТО розвивати навички розв'язування задач, необхідні у відповідних галузях професійної діяльності. Незважаючи на це, існує багато свідчень того, що учні закладів ПТО в усьому світі мають слабкі математичні навички. Різні дослідження зосереджувалися на успішності та зацікавленості учнів математикою математики, але мало уваги приділялося вивченню змісту математики в професійно-технічній освіті. У цьому дослідженні представлено систематичний аналіз змісту математики у професійнотехнічній освіті з січня 2015 р. по січень 2024 р.*

Матеріали і методи. *Дані були зібрані шляхом аналізу 17 статей з математики в ПТО із загального пошуку Google Scholar, Scopus, журналу Eric та бази даних EBSCOHost. Числові дані були представлені у вигляді відсотків і частот, тоді як якісні дані були проаналізовані тематично.*

Результати. *Дослідження показало, що найбільше статей було опубліковано у 2022 році, далі йдуть 2017 та 2021 роки. Найменше статей було опубліковано у 2015, 2018 та 2020 роках. Результати також показали, що більшість авторів пов'язані з Південною Африкою, за нею йдуть Швеція та Індонезія, а найменше – з Туреччиною та Катаром. Науковці зосереджуються на двох основних темах: викладання математики у закдаах ПТО та важливість математики для ПТО.*

Висновки. *Результати підкреслюють важливість додаткових досліджень у цій галузі для підвищення якості математичної освіти в закладах ПТО в усьому світі з метою задоволення потреб швидкозмінного ринку праці.*

КЛЮЧОВІ СЛОВА: *систематичний огляд; бібліометричний аналіз; зміст математики; професійно-технічна освіта; компетентності.*

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THE STUDY OF MATHEMATICS CONTENT IN THE CONTEXT OF VOCATIONAL EDUCATION: A SYSTEMATIC REVIEW

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ABSTRACT

Formulation of the problem. *Mathematics is fundamental to Technical and Vocational Education and Training (TVET). This is because mathematics enables TVET students to develop the problem-solving skills required in their respective trade areas. Despite this, there is ample evidence that TVET students around the world have poor mathematical skills. To address this issue, various studies have focused on TVET students' performance and interest, teaching mathematics in vocational education, and the relevance of mathematics, with little emphasis on the study of mathematics content in vocational education. This current study presents a systematic analysis of mathematics content in vocational education from January 2015 to January 2024.*

Materials and methods. *Data were collected by analyzing 17 articles on mathematics in TVET from Google Scholar general search, Scopus, the Eric journal, and the EBSCOHost database. The numerical data were presented as percentages and frequencies, whereas the qualitative data were analysed thematically.*

Results. *The study found that the majority of articles were published in 2022, followed by 2017 and 2021. However, the fewest number of articles were published in 2015, 2018, and 2020. The findings also revealed that the majority of authors are affiliated with South Africa, followed by Sweden and Indonesia, with Turkey and Qatar having the fewest affiliations. Finally, the findings revealed that the authors focused on two major themes: teaching mathematics in the context of TVET and the importance of mathematics in TVET.*

Conclusions. *This review emphasizes the importance of additional research in this area to improve the quality of mathematics education in TVET programs around the world in order to meet the workforce's changing needs.*

KEYWORDS: *systematic review; bibliometric analysis; mathematics content; technical and vocational education and training; competencies.*

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INTRODUCTION

Technical and Vocational Education and Training (TVET) is critical for providing individuals with the skills required for careers in a variety of industries (Okolie et al., 2020). This is because TVET programs are tailored to the needs of the job market, ensuring that students who complete TVET training have the necessary skills to find work in their desired fields or start their own

businesses (Ngware et al., 2024). This is consistent with SDG 4 Agenda 2030 target 8.6, which states that in order to address both current and future issues, individuals must be empowered to become effective and resilient. This will ensure that TVET remains relevant to the economy and society (Keevy et al., 2021). To keep up with changes in sustainability, environmental protection, migration, and digital technology, technical and vocational education and training (TVET) must update its facilities, skills, and methods more quickly than previously (Keevy et al., 2021).

To accomplish this, TVET students must have strong problem-solving abilities, which is one of the focuses of mathematics. To ensure this, research studies have highlighted the need for TVET students to acquire the mathematics competencies and skills required to comprehend the concepts taught in various TVET programs (Frejd & Muhrman, 2022). As a result, incorporating mathematics content into TVET programs is critical to ensuring that students have the necessary knowledge and skills to excel in their chosen vocations (Dalby & Noyes, 2015). FitzSimons and Boistrup (2018), for example, claimed that all types of skilled work contain elements of mathematics (including statistics), which are used explicitly or implicitly, and sometimes completely embedded within vocational activities. In line with this, Jassem and Alyaqout (2018) stated that mathematical competencies such as measurement, geometric calculations, and trigonometry are essential in preparing students for successful careers in welding and fabrication.

Despite the importance of mathematics in TVET, there is a lack of research into the specific mathematical concepts covered in TVET programs. A systematic review of the literature is required to determine current trends, areas for improvement, and the focus of previous studies. As a result, the purpose of this study is to conduct a thorough examination of the current body of literature on the mathematical content included in TVET programs worldwide from 2015-2024, as well as the literature's trend and the focus of previous studies. The findings of this study will fill gaps in the literature and have important implications for educators, policymakers, and stakeholders involved in TVET programs. This study aims to contribute to ongoing efforts to improve mathematics education in TVET programs by identifying best practices and areas for improvement.

Research Questions

The present systematic review was guided by two research questions:

1. What is the distribution of articles by date and country of affiliation/publication?
2. What is the primary focus of the articles on mathematics and TVET?

RESEARCH METHODS

Search Strategy

Various search techniques were used to locate relevant papers through online database searches that best matched the study's goal. In addition to specific search terms, the researcher used ancestor search techniques, which involved looking through previously identified literature references to find additional relevant papers for the study (Cooper, 2010). This method provided valuable context for the systematic review. To reduce bias in the study, the number of articles published on websites has nearly reached its limit. Online databases such as Eric, Google Scholar, Scopus, and EBSCOHost were used to collect relevant papers for the study. This is due to the study's focus on education, and the sources are the most widely used databases in both the social sciences and education. The three sources were also well-established and recognized in the field of social sciences, which includes this study. Lastly, these sources provided free databases that increased the researcher's access to the relevant literature. The following keywords: "mathematics content for TVET," "Mathematics for masonry, carpenters, welders, seamstress, engineers," "integration of mathematics in TVET program," "Importance of mathematics in TVET," "how mathematics is taught in TVET schools," "improving TVET students interest in Mathematics," etc, "mathematics competencies for TVET" were used to begin the search online. To ensure more thorough and comprehensive coverage of mathematical content in vocational education, each keyword was run independently in each database. Only peer-reviewed journals were considered in the study because they provided the most reliable source of scientific data and improved the study's quality.

Study Selection

This systematic review was conducted from January 2024 to July 2024. The article search for the review began on January 5th, 2024. Initially, the internet search returned 779 articles from the four databases. The articles are distributed according to the databases Eric (117), Google Scholar (313), Scopus (252), and EBSCOHost (97). Before exporting the remaining articles (78) to Mendeley, a manual screen was performed to remove the 701 articles that had been eliminated. The abstracts and titles were thoroughly reviewed and screened using the Mendeley software. At this level, 47 articles were removed from the total because their topics and abstracts did not align with the focus of this study, leaving 31 articles to be evaluated for eligibility using full-text articles. At this point, 14 of the 31 articles had been eliminated, leaving only 17 articles. The 14 articles that were excluded consisted of 9 duplicates and 5 irrelevant articles. For the purposes of this systematic review, the 17 articles were synthesized. Figure 1 depicts an overview of the systematic literature review search protocol, which is based on Moher et al.'s (2009) 'Preferred Reporting Items for Systematic Reviews and Meta-Analysis' (PRISMA).

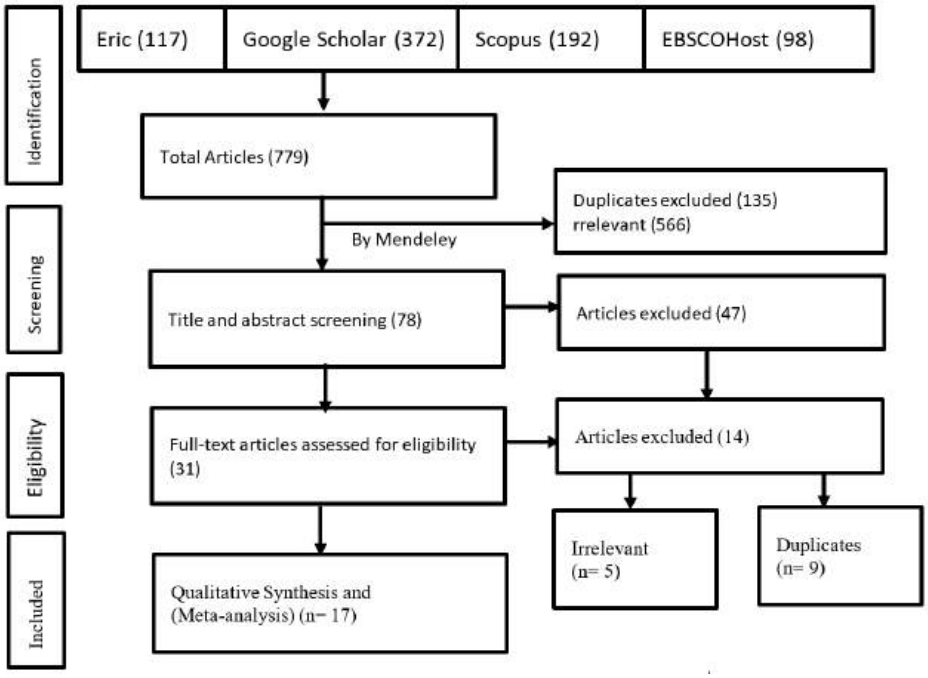

Fig. 1. Flow Diagram of Studies' Screening and Selection (based on PRISMA)

Source: Own Work

Inclusion Criteria

To identify the literature included in the study, an inclusion criterion was followed, as shown in Table 1.

Table 1. Inclusion Criteria for the Systematic Review

Criterion	Inclusion criteria
Period of the empirical studies	Articles published between January 2015 and January 2024 were selected for the study because they are considered current literature and provide current information on mathematics content for vocational education.
Level of education	Elementary, secondary, and tertiary
Focus	mathematics content in the context of vocational education
Research approach	Qualitative, quantitative, and mixed methods
Geographical Spread	Across the globe
Design	survey, case study, and document analysis
Research Base	Empirical evidence forms the base of the study

Source: Own Work

Evaluation of the Methodological Quality

In an analysis of multiple reviews, the credibility of the findings is determined by the outcomes of the included reviews, which are based on the findings of the original studies in each review. Two critical questions were raised: 1. Was the review properly conducted, and 2. Was the quality of the primary studies assessed in the review? These questions were answered with an adjusted version of the 'assessment of multiple systematic reviews' (AMSTAR) tool (Shea et al., 2007). It is important to note that reviews were not disregarded due to their quality.

Data Extraction and Analysis

To extract each downloaded article, the researcher's bibliometric analysis sheet/table was utilized. The table was created based on the study's inclusion criteria. Author's name, context, book/thesis/articles. Context (study area), topic, contribution, research design, findings/conclusions, and what the author(s) left out (limitation). Other characteristics discovered in the literature were determined by the research questions. The first research question was presented using frequencies and percentages, while the second was thematically analysed.

RESEARCH RESULTS

The analysis included 17 empirical articles from a systematic review of educational research published between January 2015 and January 2024 on mathematics content in vocational education settings. The results showed that the majority of the articles were published in 2022, followed by 2017 and 2021. However, the lowest number of articles was published in 2015, 2018, and 2020, accounting for only 5.9%. This could be due to a lack of attention paid to articles about mathematics content in TVET education during those years. It can also be seen that South Africa is the country of affiliation for the most authors, with 29.4% representing five articles. Sweden and Indonesia had the next highest number of published articles after South Africa. Turkey and Qatar, on the other hand, had the fewest number of published articles. The disparity in affiliation could be attributed to funding for research and publishing in the field of TVET education, as well as the fact that mathematical content is more readily available

in those countries. Countries with strong research infrastructure, such as well-equipped universities, research centers, and libraries, may have more resources available for researchers to conduct studies on TVET education and mathematical content (Tun & Juchelková, 2022).

Research Question One: Distribution of the Articles according to Date and the Country of Affiliation/Publication?

Table 2. Distribution of the Articles according to Date and the Country of Affiliation/Publication

	Frequency	*Percentages*
Year of Publication		
2015	1	5.9
2017	3	17.6
2018	1	5.9
2019	2	11.8
2020	1	5.9
2021	2	11.8
2022	5	29.4
2023	2	11.8
Country of Affiliation/Publication		
Indonesia	3	17.6
Qatar	1	5.9
South Africa	4	23.5
Sweden	3	17.6
Turkey	1	5.9
UK	2	11.8
USA	3	17.6

Source: Own Work

Researchers in countries with established research networks and partnerships may have more opportunities to collaborate on studies involving TVET education and mathematical curriculum (Schröder, 2019). Collaborations with scholars from other countries can also result in more diverse and extensive investigations, which lead to more publications (Hoekman et al., 2010; Bozeman et al., 2013). Some countries may prioritize TVET education and mathematics content in their national policies and objectives (Ayonmike et al., 2015). The bibliometric analyses of the articles are shown in Table 3.

Research Question Two: What are the main focuses of the articles on mathematics content and TVET?

The articles revealed two major themes: the application of mathematics in TVET and the teaching of mathematics in TVET schools. Thirteen of the 17 articles focused on mathematics teaching in TVET schools, while the other four articles focused on mathematics application in TVET. This indicated that researchers are interested in the application of mathematics to specific trade areas, as well as the effectiveness of mathematics education in TVET schools.

The study found that the authors focused on two major issues. These were the teaching of mathematics in TVET (Dalby & Noyes, 2015; Mustakim, 2017; Kelly, 2018; Said, 2021; Frejd & Muhrman, 2022; Tarhan et al., 2021; Muhrman, 2022; Vimbelo & Bayaga, 2023) and the importance of mathematics in TVET (FitzSimons & Boistrup, 2017; Dominikus et al., 2017; Deda & Amsikan, 2019). Researchers are interested in the mathematics competencies required in various TVET programs, as well as the most effective ways to develop these skills in students. Mathematics plays an important role in technical and vocational education, according to studies.

All TVET trades require some basic mathematics, particularly in technology, engineering, construction, welding, and fabrication. For example, welding and fabrication necessitate a variety of mathematical concepts when forming, arranging, and welding materials. Almost every trade requires material cost calculation and profit estimation (Jassem & Alyaqout, 2018). For example, Deda and Amsikan (2019) demonstrated that traditional woven fabric motifs in the Kefamenanu community necessitate a wide range of geometric concepts. Jassem and Alyaqout (2018) also agreed that mathematical calculations are required in welding before beginning any project or producing any product. This ensures that the welder receives the proper welding dimensions, materials for the welding process, the most cost-effective materials, and the time required to complete a specific product (Jassem & Alyaqout, 2018). According to Istas et al. (2021), mathematics and algebra are extremely important in engineering work, despite the fact that most university students do not apply them. A variety of mathematical concepts are used in carpentry and joinery, including angle, geometry, trigonometry, area, volume, ratio and proportion, and bearing.

FitzSimons and Boistrup (2017) also stated that all forms of skilled work contain elements of mathematics (including statistics), which are used explicitly or implicitly, and sometimes completely embedded within vocational activities. As a result, it is possible to conclude that all successful TVET programs require some level of mathematical competency. The findings also highlighted ways to improve mathematics education in TVET. Because mathematical competencies are required in all TVET areas, it is expected that relevant mathematical concepts and skills be integrated into TVET courses and effectively taught to TVET professionals. Frejd and Muhrman (2022) recognized the need for greater integration of mathematics and vocational subjects in the classroom setting. The mathematics curriculum should be tailored to the specific competencies required in the learners' trade areas, allowing them to immediately apply their mathematical skills and competencies in their chosen fields. Furthermore, contextualized mathematics instruction in TVET institutions has been shown to improve students' mathematical achievement (Mustakim, 2017).

In England, for example, mathematics (as a compulsory component of the program for vocational students) is taught in accordance with the specific context and practical needs of the various TVET (Dalby & Noyes, 2015). Mirabueno and Boyon

(2020), in their study of students' mathematics performance from junior to senior high school, recommended that senior high school mathematics subjects be designed to teach skills relevant to the students' chosen tracks. This is consistent with Lave and Wenger's (1991) situated learning theory, which states that learning is situated in the "activity, context, and culture in which it occurs" (Lave & Wenger, 1991). Given the importance of vocational education programs, mathematics taught in schools should be able to address the skills required in various industries to propel the economy forward.

Table 3. Bibliometric Analysis of the Articles

Author(s) Name	*Topic*	*The country of affiliation/publication*	*Year*
1. Diane Dalby and Andrew Noyes	Connecting Mathematics Teaching with Vocational Learning	UK	2015
2. P. Frejd & K. Muhrma	Is the mathematics classroom a suitable learning space for making workplace mathematics visible?– An analysis of a subject-integrated team teaching approach applied in different learning spaces	Sweden	2022
3. Irfan Rusmar and Mustakim	Teaching Mathematics In Technical Vocational Education (TVET)	Indonesia	2017
4. Gail E. FitzSimons and & Lisa Björklund Boistrup	In the workplace, mathematics does not announce itself: towards overcoming the hiatus between mathematics education and work	Sweden	2017
5. Karolina Muhrman	How can students in vocational education be motivated to learn mathematics?	Sweden	2022
6. Makhosi P. Madimabe, Bunmi I. Omodan, and Cias T. Tsotetsi	Indigenous Knowledge As An Alternative Pedagogy To Improve Student Performance In The Teaching And Learning Of Mathematical Geometry In Tvet College	South Africa	2020
7. Makhosi P. Mademabe, Bunmi Isaiah Omodan, and Cias T. Tsotetsi	Incorporation of Indigenous Knowledge in the Mathematical Geometry Discipline at a TVET College	South Africa	2022
8. Siphokazi Vimbelo and Anass Bayaga	Humanising Pedagogy in Mathematics Education at South African Technical and Vocational Education and Training (TVET) Colleges: Influence on TVET Teaching and Learning	South Africa	2023
9. S. Vimbelo and A. Bayaga	Current Pedagogical Practices Employed By A Technical Vocational Education And Training College's Mathematics Lecturers	South Africa	2023
10. Ziad SAID	Integrating STEM in to TVET Education Programs in Qatar: Issues, Concerns and Prospects	Qatar	2021
11. Beth Kelly	Motivating adults to learn mathematics in the workplace: a trade union approach	UK	2018
12. Brooke Istas and Candace Walkington	When Am I (N)ever Going to Use This? How Engineers Use Algebra (NSF DRL)	USA	2022
13. Tracy E. Dobie	Expanding conceptions of utility: middle school students' perspectives on the usefulness of mathematics	USA	2019
14. Yohanis Ndapa Deda), Stanislaus Amsikan	Geometry Concept on the Motifs of Woven Fabric in Kefamenanu Community	Indonesia	2019
15. Leyva, C Walkington, H Perera, M Bernacki	Making mathematics relevant: An examination of student interest in mathematics, interest in STEM careers, and perceived relevance	USA	2022
16. Murat Tarhan, Elif Nur Akkaş & Ülkü Ayvaz	Gaining entrepreneurship skills in mathematics education: the middle school mathematics course curriculum of Turkey	Turkey	2021
17. WS Dominikus, T Nusantara, MM Subanji, M Muksar	Ethnomathematical ideas in the weaving practice of Adonara Society	Indonesia	2017

Source: Own work based on the systematic review of literature like Leyva et al. (2022), Tarhan et al. (2021), etc.

Muhrman (2022) supported this by stating that mathematics instruction should be relevant to the workplace. That is, teachers are expected to select mathematical content and examples that are relevant to the specific subject matter being taught. According to Hodgen et al. (2018), mathematics instruction in TVET institutions can be taught separately, as part of vocational instruction, or as part of vocational competencies without being recognized as mathematics. In most countries, such as Germany, Singapore, and Korea, mathematics is embedded in a specific TVET trade area, and students learn it as part of their chosen TVET. Kelly (2018) also stated that workers can be motivated to learn mathematics at work by aligning mathematical concepts with their professions. To summarize, when mathematics is made more meaningful to TVET students in relation to their chosen career or daily life, they will develop a positive attitude toward it and an interest in mathematics.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The systematic review sought to assess the mathematics content and TVET. The study focused on the review of related articles from January 2015 to January 2024. The systematic review of literature on mathematics content in vocational education revealed significant trends. The majority of articles were published in recent years, with 2017 and 2018 having the most publications, indicating a growing interest in the topic during those years. The predominance of qualitative research methods indicates a focus on in-depth exploration and comprehension of the subject. The concentration of articles from South Africa, Sweden, and Indonesia demonstrates a global perspective on the integration of mathematics in TVET. However, the low representation of countries such as Turkey and Qatar suggests that more research is needed in these areas. The articles focused primarily on the application of mathematics in TVET and the effective teaching of mathematics in TVET schools. However, the research literature shows a noticeable lack of representation from the majority of African countries. This study has no limitations. Some of the articles reviewed did not address ethical concerns (Mustakim, 2019; Frejd & Muhrman, 2022). Furthermore, some of these articles lack theoretical frameworks to back up their findings (Dalby & Noyes, 2015). Furthermore, this study did not include other types of research, such as doctoral theses and book chapters. This may result in the loss of important information and have an impact on the research findings. This review emphasizes the importance of additional research in this area to improve the quality of mathematics education in TVET programs around the world in order to meet the workforce's changing needs.

The current study focused on a systematic review of mathematics content and TVET. The study was primarily concerned with the distribution of studies on mathematics content and TVET, as well as the primary focus of the articles on these topics. Further research can investigate the alignment between the content of mathematics taught and the competencies required in TVET in various countries. A study can also conduct comparative studies across multiple countries to gain a more comprehensive understanding of how mathematics is integrated into TVET programs around the world. This can help identify best practices and areas for improvement in a variety of settings. Furthermore, more research is needed to investigate the specific challenges and barriers encountered in countries such as Turkey and Qatar when implementing effective mathematics education in TVET schools, as well as to propose strategies for improvement. Finally, future research could look into the impact of industry partnerships and collaborations on improving the relevance of mathematics education in TVET programs and preparing students for the demands of the workforce.

CONFLICT OF INTEREST

The authors declare no financial, personal, or other interests that could be considered a potential conflict of interest regarding the publication of this article.

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DATA AVAILABILITY

This is a theoretical study and does not involve the use of any additional datasets.

USE OF ARTIFICIAL INTELLIGENCE (AI) TOOLS

AI tools were not used in the writing of this work.

REFERENCES

1. Akkas, E. N., Tarhan, M., & Ayvas, Ü. (2020). Gaining Entrepreneurship Skills with the Activities Designed Related to Primary School Mathematics Curriculum: The Case of Turkey. *Acta Didactica Napocensia*, 13(2), 93-112.
2. Ayonmike, C. S., Okwelle, P. C., & Okeke, B. C. (2015). Towards Quality Technical Vocational Education and Training (TVET) Programmes in Nigeria: Challenges and Improvement Strategies. *Journal of Education and Learning*, 4(1), 25-34.
3. Bozeman, B., Fay, D., & Slade, C. P. (2013). Research collaboration in universities and academic entrepreneurship: the state of the art. *The journal of technology transfer*, 38(1), 1-67.
4. Cooper, H. (2010). Research synthesis and meta-analysis: *A step-by-step approach* (4th ed.). Los Angeles: Sage.
5. Dalby, D., & Noyes, A. (2015). Connecting Mathematics Teaching with Vocational Learning. *Adults Learning Mathematics*, 10(1), 40-49.
6. Deda, Y. N., & Amsikan, S. (2019). Geometry concept on the motifs of woven fabric in Kefamenanu community. *Journal of Research and Advances in Mathematics Education*, 4(1), 23-30.
7. Dobie, T. E. (2019). Expanding conceptions of utility: middle school students' perspectives on the usefulness of mathematics. *Mathematical Thinking and Learning*, 21(1), 28–53. https://doi.org/10.1080/10986065.2019.1564969
8. Dominikus, W. S., Nusantara, T., Subanji, M. M., & Muksar, M. (2017). Ethnomathematical ideas in the weaving practice of Adonara Society. *Journal of Mathematics and Culture*, 11(4), 83-95.
9. FitzSimons, G. E., & Boistrup, B. L. (2017). In the workplace, mathematics does not announce itself: Towards overcoming the hiatus between mathematics education and work. *Educational Studies in Mathematics*, 95, 329-349.
10. Frejd, P., & Muhrman, K. (2022). Is the mathematics classroom a suitable learning space for making workplace mathematics visible ? – An analysis of a subject integrated team-teaching approach applied in different learning spaces. *Journal of Vocational Education & Training*, 74(2), 333–351. https://doi.org/10.1080/13636820.2020.1760337
11. Hodgen, J., Wake, G., & Dalby, D. (2017). Mathematics in the successful technical education of 16-19 year olds. *London: Gatsby. Retrieved January 17*, 2020.
12. Hoekman, J., Frenken, K., & Tijssen, R. J. (2010). Research collaboration at a distance: Changing spatial patterns of scientific collaboration within Europe. *Research policy*, 39(5), 662-673.

13. Howell, E., Walkington, C., Bernacki, M., & Istas, B. (2020, January). The connection between perception of utility in careers with math and STEM career interest. In *Proceedings of the 23rd Annual Conference on Research in Undergraduate Mathematics Education*.
14. Istas, B., Walkington, C., Leyva, E., & Bernacki, M. L. (2021, July). When Am I (N) ever Going to Use This? How Engineers Use Algebra (NSF DRL). In *2021, ASEE Virtual Annual Conference Content Access*.
15. Jassem, A. H. N., & Alyaqout, H. M. A. (2018). Mathematics in Welding Design. *Journal of Mechanical and Civil Engineering, 15*(6), 78–83. https://doi.org/10.9790/1684-1506017883
16. Keevy, J., Shiohira, K., Matlala, R., & Molokwane, P. (2021). TVET Delivery: Providing Innovative Solutions. New Qualifications and Competencies for Future-Oriented TVET. Volume 3. *UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training*.
17. Kelly, B. (2019). Motivating adults to learn mathematics in the workplace: A trade union approach. *International Journal of Lifelong Education*, 38(2), 132-147.
18. Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.
19. Leyva, E., Walkington, C., & Perera, H. (2022). Making Mathematics Relevant : an Examination of Student Interest in Mathematics, Interest in STEM Careers, and Perceived Relevance. *International Journal of Research in Undergraduate Mathematics Education*, 612–641. https://doi.org/10.1007/s40753-021-00159-4
20. Madimabe, M. P., Bunmi, I. O., & Cias, T. T. (2020). Indigenous knowledge as an alternative pedagogy to improve student performance in the teaching and learning of mathematical Geometry in TVET College. *Proceedings of ADVED*, 2020(6th).
21. Madimabe, M. P., Omodan, B. I., & Tsotetsi, C. T. (2022). Incorporation of Indigenous knowledge in the mathematical geometry discipline at a TVET college. *Journal of Research in Mathematics Education*, 11(3), 296-312.
22. Mirabueno, J. A. S., & Boyon, M. C. L. (2020). Senior high school academic progression in mathematics. *PEOPLE: International Journal of Social Sciences*, 5(3), 840-849.
23. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement, *PLoS Medicine, 6(7), e1000097*.
24. Muhrman, K. (2022). *How can students in vocational education be motivated to learn mathematics?* 12(3), 47–70.
25. Mustakim, I. R. (2017). Teaching mathematics in technical vocational education (TVET). In *Proceedings of the 1st International Conference on Innovative Pedagogy (ICIP) 2017.* STKIP Bina Bangsa Getsempena.
26. Ngware, M. W., Ochieng', V., Kiroro, F., Hungi, N., & Muchira, J. M. (2024). Assessing the acquisition of whole youth development skills among students in TVET institutions in Kenya. *Journal of Vocational Education & Training*, 76(1), 197-222.
27. Okolie, U. C., Elom, E. N., Igwe, P. A., Nwajiuba, C. A., Binuomote, M. O., & Igu, N. (2020). How TVET teachers foster employability skills: insights from developing countries. *International Journal of Training Research*, 18(3), 231-249.
28. Said, Z. (2021). Integrating STEM into TVET education programs in QATAR: Issues, concerns, and prospects. *The Eurasia Proceedings of Educational and Social Sciences*, 23, 15-24.
29. Schröder, T. (2019). A regional approach for the development of TVET systems in the light of the 4th industrial revolution: the regional association of vocational and technical education in Asia. *International Journal of Training Research*, 17(sup1), 83-95.
30. Shea, B. J., Grimshaw, J. M., Wells, G. A., Boers, M., Andersson, N., Hamel, C., ... & Bouter, L. M. (2007). Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Medical Research Methodology*, 7, 1-7.
31. Tarhan, M., Akkaş, E. N., & Ayvaz, Ü. (2022). Gaining entrepreneurship skills in mathematics education: the middle school mathematics course curriculum of Turkey. *International journal of mathematical education in science and technology*, 53(12), 3228-3249.
32. Tun, M. M., & Juchelková, D. (2022). A Preliminary Approach toward Development of the TVET Research and Development (R&D) Sector for Sustainable Development in Myanmar. *Sustainability*, 14(9), 5474.
33. Vimbelo, S., & Bayaga, A. (2023A). Humanising pedagogy in mathematics education at South African technical and vocational education and training (TVET) colleges: Influence on TVET teaching and learning. *International Journal of Learning, Teaching and Educational Research*, 22(9), 633-655.
34. Vimbelo, S., & Bayaga, A. (2023B). Current pedagogical practices employed by a technical vocational education and training College's mathematics lecturers. *South African Journal of Higher Education*, 37(4), 305-321.

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