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The Implementation of Dual Language Programme for Mathematics Education in Secondary Schools: A Systematic Literature Review

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Abstract: The study discussed in this paper is a systematic literature review related to the role of dual language programme (DLP) in mathematics education which has been published within the last 5 years. This study was conducted to identify the distribution of DLP studies in terms of year of publication, the study context covered in previous studies, the context of study areas used, focus and trends of past studies, research methods used in previous studies and the role of language in school mathematics education. This review study followed the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) to analyze articles from Scopus and Web of Science. The findings of the study indicate that research trends in the implementation of the DLP on mathematics education for secondary school students showed an increase from 2017 to 2019. Most DLP-related articles are widely developed in the United States and Germany. The findings indicate that previous studies are more interested in studying the implementation of DLP in rural areas. Past studies have also preferred to use the design of either a qualitative study or a quantitative study to be implemented. Questionnaires, tests and interviews are among the research instruments that are often used for a study.

Keywords: *Bilingual, dual language programme (DLP), mathematics, PRISMA, systematic literature review.*

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Introduction

The increased implementation of dual language programme (DLP) for mathematics education in recent years has been carefully documented in related research (Borgonovia & Ferrara, 2020; Pierson et al., 2021; Tai & Wei, 2021; Yılmaz et al., 2021) included in the high school context. The relationship between language proficiency and achievement mathematics has been discussed for tests primarily related to language communicative function (Morita-Mullaney et al., 2021; Prediger et al., 2018; Watzinger-Tharp et al., 2018). To date, there is growing evidence to suggest that Dual Language Programme (DLP) has a beneficial effect on science, technology, engineering and mathematics (STEM) subjects (Ibrahim & Alhosani, 2020; Pierson et al., 2021), motivation (Suliman et al., 2020; Tai & Wei, 2021), reasoning thinking (Tarasenkova et al., 2020) and conceptual understanding (Maluleke, 2019; Schüler-Meyer, 2017). The use of English in the mathematics subject includes either oral or written usage during teaching and learning sessions as well as during examinations. According to Riordain and Mccluskey (2015), when students are involved in bilingualism for the subject of mathematics, it is very important for students to address the social problems of language use in context and not just the role in cognition. Therefore, it is vital for researchers to study the implementation of DLP in school children in order to encourage mental development for students, formation of cognitive skills and practical application of acquired knowledge in life (Khuziakhmetov et al., 2020).

The implementation of DLP is also not a new language immersion program on a global scale, as it is used in countries such as Japan, Finland and the United States (US) (Ramli et al., 2020). This shows that Malaysia is not the only one implementing DLP. In fact, DLP is also involved with education which involves bilingualism (Suliman et al., 2021). The implementation of DLP in Malaysia provides students the option to choose the medium of instruction (English or Malay) for courses such as science and mathematics taught in schools (Othman et al., 2020). Furthermore, according to Ramli et al. (2020), the same implementation is also practised in countries in Europe and North America where foreign languages are used to teach and learn non-language subjects. This shows that the implementation of DLP in countries

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other than Malaysia is mostly for students who migrate to a new country. Thus, the implementation of DLP involves two different languages used during teaching and learning included in the subject of mathematics.

In Malaysian settings, DLP is a program implemented as an option for students to use English fully in teaching and learning sessions for STEM subjects. Students in secondary schools are given the option to choose either the class stream for STEM subjects in Malay or English. However, there are some constraints in the implementation of DLP in mathematics education (Bullah & Yunus, 2018; Lee & Jeong, 2013; Moses & Malani, 2019; Rashid et al., 2017). For example, studies revealed that students find it difficult to learn mathematics and science in English because they are not proficient in English (Rashid et al., 2017). Therefore, to have a better understanding of how DLP has been used in mathematics instruction, the systematic literature review (SLR) was conducted to assess and explain the implementation of DLP on mathematics education of secondary school students, published within the last 5 years. Rasidi and Mydin (2020) performed the current DLP literature review, which looked at the existing research in the Malaysian setting. However, only a few SLR had been found on the implementation of DLP on mathematics education especially in the broader context. The question is still unanswered on the DLP implementation in mathematics education in the current empirical study. As such, this point indicates that it is important to conduct a SLR in the implementation of DLP in mathematics education. This is so that this study can contribute to the literature related to mathematics education of secondary school students. The questions of this study are stated as follows:

1. How is the DLP study distributed in terms of the year of publication?
2. What is the geographical area covered in the previous study?
3. What is the research location in the previous study?
4. What was the research design utilised in the previous study?
5. Which research instruments were used in the previous study?
6. What is the role of language in the mathematics education of secondary school students?

Literature Review

The implementation of DLP, also known as dual language immersion (DLI) (Lee & Jeong, 2013; Watzinger-Tharp et al., 2018), is also highly related to bilingualism (Suliman et al., 2021). Bilingualism involves the use of languages other than the first language in the learning process (Suliman et al., 2021). The use of English in the subject of mathematics includes either spoken or written English used during the teaching and learning sessions as well as during examinations. According to Ester et al. (2021), learning mathematics in a bilingual environment is far more challenging than in a monolingual classroom. However, as stated by Riordain and Mccluskey (2015), when students are involved in bilingualism for the mathematics subjects, it is very important for students to address social problems of language use in context and not just a role in cognition. Therefore, it is significant that researchers study the implementation of DLP in school children in order to create mental development for students, formation of cognitive skills and practical application of acquired knowledge in life (Khuziakhmetov et al., 2020).

Moreover, there is an increase in the number of emerging Spanish-speaking bilingual children in the United States and schools need inclusive ways to meet the educational needs of this population (Alamillo et al., 2017). Thus, the term english language learners (ELL) exists widely from pupils entering the education system who do not speak any English or have very limited knowledge of English (Shatz & Wilkinson, 2010). According to Lindholm-Leary and Hernández (2011), students in *English and are reclassified fluent English proficient* (called RFEP in California) get the highest marks even though they enter school as ELL. They continue to develop their English to a level beyond the students' level of current ELL, both in oral language proficiency and in literacy. Novotná and Hofmannová (2000) introduce Content and Language Integrated Learning (CLIL) as a broad expression used to refer to any teaching of non-language subjects through second or foreign language intermediaries as well as to refer to the teaching of non-linguistic subjects such as mathematics through an additional language. Therefore, students involved with DLP are also known as ELL, CLIL and RFEP.

Good bilingual proficiency has proven valuable in intelligence tests designed specifically for the language independent (Farrell, 2011). Apart from proficiency in bilingualism, according to Mearns et al. (2020), exposure to bilingual education reinforces the idea that motivation may exist in this group of CLIL students. However, there is little difference between the level of motivation of students at the beginning of their studies in bilingual education and those who are more experienced (Mearns et al., 2020). Students in bilingual education are more motivated than their mainstream peers; and secondly, whether the motivation appears to be diachronically related to exposure to bilingual education (Mearns et al., 2020). These cross-linguistic differences can affect, in many ways, ELL's ability to decode and spell in English, interfering with academic language proficiency achievement (Shatz & Wilkinson, 2010). According to Farrell (2011), highly proficient students in both languages performed best in physics and mathematics examinations. Additionally, based on the study of Han and Ginsburg (2001), student achievement showed that Chinese-speaking and

bilingual groups scored higher on special mathematics tests than English-speaking students. Thus, the implementation of DLP also touches on the competence, motivation and achievement of students in mathematics.

Methodology

We conducted a systematic literature review (SLR) to focus on relevant research on DLP for mathematics education in secondary schools. SLR assists the study in obtaining a number of literature that meet the objectives of the study as well as to clearly see the phenomena which occur around the keywords of the study (Abd Rahman et al., 2017). In addition, SLR method covers the year of study, background, research problems, methods and findings of the study as well as applying a systematic search to identify the need for sustainable translation strategies in producing translations of elements required in the study (Kamal & Hussin, 2020). The statement of preferred reporting items for systematic reviews and meta-analysis (PRISMA) (Moher et al., 2009), and flow charts were used in this review because they were designed to assist in synthesizing journal articles that related. The implementation of a review protocol, publishing standard, or defined criteria can help guide and keep researchers on route while also boosting the review's methodological openness (Haddaway et al., 2018). SLR is divided into seven primary parts (Mohamed Shaffril et al., 2021) namely (a) the formulation and confirmation the review procedure standard/guidelines, (b) the creation of research questions, (c) exploration approaches which are systematic, (d) evaluation of quality, (e) data extraction, (f) synthesis of data, and (g) presentation of data.

PRISMA is designed for writers who are writing systematic review guidelines for publication, mass consumption, or other purposes (Shamseer et al., 2015). PRISMA is a guide used consisting of four phases of flow diagram (Selçuk, 2019) namely identification, screening, eligibility and included documents. The first process is identifying the number of articles found from the database such as Scopus and Web of Science (WoS). The second process is the screening of the number of records after a duplicate is removed (Moher et al., 2009). The third process involves eligibility or the number of full text articles which are eligible to be evaluated. The final process refers to the inclusion of studies in the qualitative synthesis (Maamin et al., 2020). The following is a picture of Figure 1 related to article screening using the PRISMA method. The two authors separately carried out the whole screening procedure in the PRISMA procedure.

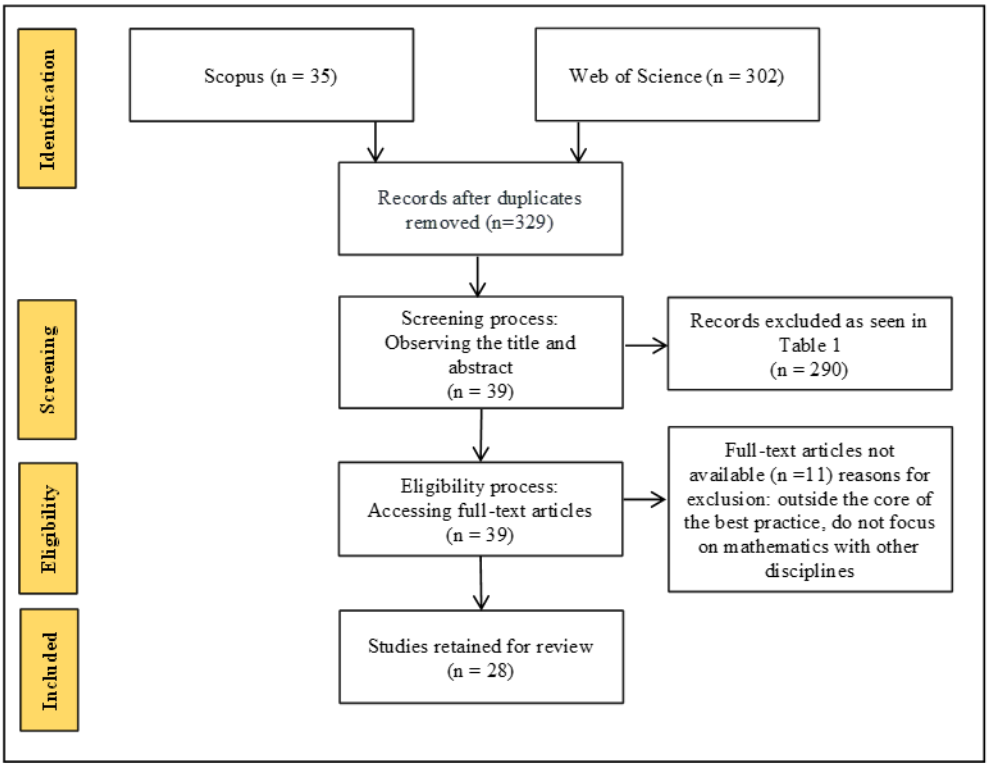

Figure 1. PRISMA Flow Diagram

Research Procedures

The articles were selected using certain criteria, selected from authentic sources namely Scopus and WoS and screened using the PRISMA method. Scopus was chosen because this database provides access to journal articles of the international, scientific, technical and medical publishers. Journals and references included in the articles allow researchers to search forward and backward in time (Burnham, 2006). WoS was chosen as the oldest, most widely used and authoritative research database in the publishing world as well as its selective, structured, balanced database with complete citation links and enhanced metadata which supported a wide range of information purposes (Birkle et al.,

2020). The study procedure began with a data collection process. In September 2021, the databases Scopus and Web of Science were searched. The selection of evaluated studies was collected through an academic search network in various databases. The entry and exclusion selection criteria were applied through specific keyword filters and searches with advanced searches on specific database websites (Lishon-Savarino, 2016). The keywords used were different syntax according to the order from the database used. For the Scopus and WoS databases, the researcher used the TITLE-ABS-KEY syntax ("mathematics education" OR "mathematics achievement" OR "mathematics accomplishment" OR "mathematics competency" OR "mathematics") AND ("dual language program" OR "bilingual "OR" english language proficiency "). This keyword was used to search for articles related to the implementation of the DLP on mathematics education.

Criteria of Inclusion and Exclusion

A table of inclusion and exclusion criteria should be addressed by every SLR (Kuckertz & Block, 2021; Mohamed Shaffril et al., 2021). However, the inclusion and exclusion criteria chosen are determined by the goals and research questions; and usually defended in terms of content, procedure, or the quality of the publication (Kuckertz & Block, 2021). According to Patino and Ferreira (2018), to address research questions, the inclusion method allows use of the target population's important attributes. At the same time, the exclusion method considers a variety of demographic factors which might block the investigation or raise the danger of unwanted outcomes, which will be ruled out of the researcher's attention. Article selection criteria including acceptance and rejection of articles in the present work were set in terms of year of publication, language, type of reference material and field of study of journal articles. For example, we excluded proceedings, conferences, newspaper clippings and books. According to Fowler et al. (2022), the methodological information in studies provided in books, book chapters, policy papers, and reports was lacking. Table 1 shows the article inclusion and exclusion criteria.

Table 1. Article Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Year of publication	Publications from 2017 to 2021	Publication before 2017
Language	Malay and English	Other than Malay and English.
Type of reference material	Journal articles	Proceedings, conferences, newspaper clippings and books
Field of study journal articles	Mathematics education. Bilingualism in the subject of mathematics	Other than mathematics education and bilingualism in the subject of mathematics

Data Analysis

The data analysis used in this study was thematic analysis. Thematic analysis is a method often used for the synthesis of qualitative and conceptual research that does not have a clear construct because each paper key is read in detail and coded in data filtering to extract general information (Cao & Shi, 2021). The themes were defined and grouped by the two independent authors by grouping the findings based on their similarity or relevance to ensure the reliability of the current work. In addition, the aim of using thematic analysis is to analyse based on previous studies and make divisions such as research methods, research design, authors and article numbers (Ummihusna & Zairul, 2021). According to Maguire and Delahunt (2017), the goal of thematic analysis is to identify themes, i.e. patterns in data that are important or interesting, and use these themes to address research or say something about an issue. Maguire and Delahunt (2017) also stated that there are five steps to implementing thematic analysis. The first is to become familiar with the data by constantly re-reading the transcript. Second, generate initial code or keywords to organize the data more systematically. Third, look for themes which are patterns or important items related to the data or research questions. Fourth, study the theme based on all the data relevant to each theme collected and consider whether the data supports the study or otherwise. Fifth, define the theme as the final completion of the theme and list feedback for the overall theme rooted in other themes. Once the thematic analysis was performed, all transcripts were listed in tabular form using Microsoft Excel to be more organized and systematic. Additionally, this study used quantitative analysis. Quantitative analysis can be utilised to study the trends and comparisons of research which have been made (Hashmi et al., 2021). According to Hashmi et al. (2021), there are several measures used for researchers to use quantitative analysis in SLR research so that they can classify data into different categories. Among them were the year of publication and journal, geographical area focused in research, country at the time of publication, research methods used in each study and instruments used for data collection. Therefore, it was appropriate to use quantitative analysis to analyse the data for this study.

Results

The sample articles were found through searches on Scopus and the WoS. A literature search returned 334 articles. After using the acceptance and rejection criteria as well as removing duplicate articles, 28 articles were used to answer the study questions. The acceptance criteria are the publication of articles from 2017 to 2021, published in Malay and

English, reference materials for journal articles and theses and the field of bilingual studies in mathematics education. The rejection criteria included the publication of articles before 2017, published in languages other than Malay and English, reference materials for proceedings, conferences, newspaper clippings and books as well as fields of study other than bilingual in mathematics education.

28 articles were used to answer the research questions after performing the review process using the PRISMA protocol. Selected articles were systematically analyzed using thematic analysis. There were six research questions : (a)how is the DLP study distributed in terms of year of publication?, (b) what is the geographical area covered in the previous study?, (c) what is research location in the previous study?, (d) what was the research design in the previous study?, (e) which research instruments were used in the previous study?, and (f) what is the role of language in the mathematics education of secondary school students? Table 2 lists and compares the selected articles.

Distribution of Studies Based on Year of Publication

The first research question focused on the DLP study distribution in terms of the year of publication. Overall, Figure 2 shows the distribution of studies in the implementation of the Dual Language Program (DLP) on mathematics education for secondary school students.

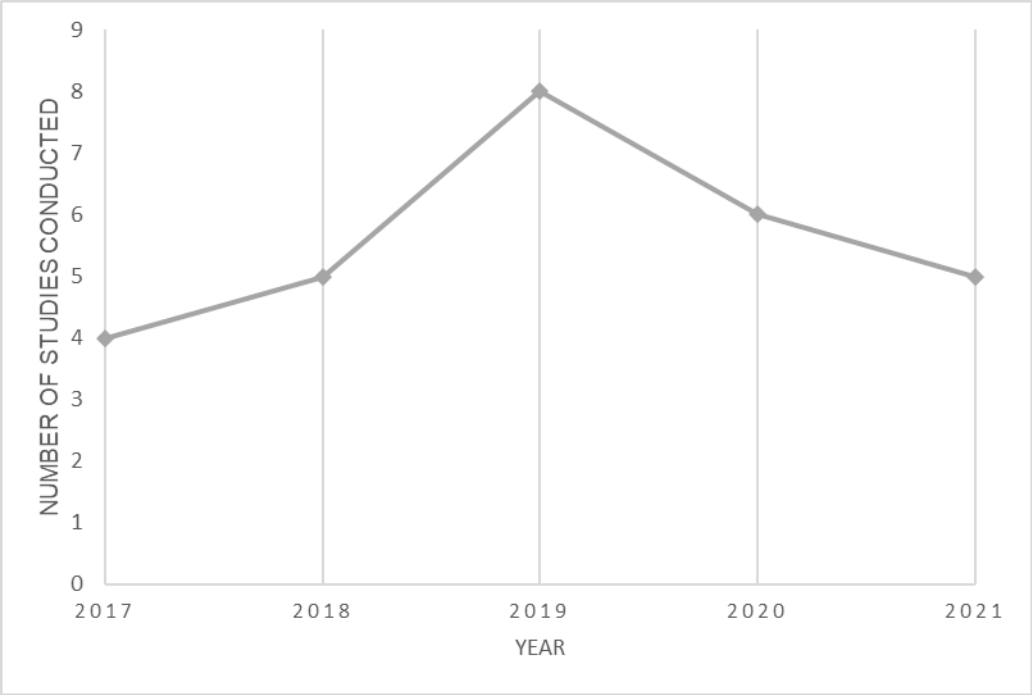

Figure 2. Research Trends

Based on Figure 2, the overall average was 5.6 per year over a 5-year period from 2017 to 2021. The research trend in the implementation of the DLP on mathematics education for secondary school students showed an increase from 2017 to 2019 but a decline from 2020 to 2021. However, most studies were conducted in 2019 (N = 8 or 29%) (e.g., Lavery et al., 2019; Ryan & Parra, 2019; Schüler-Meyer et al., 2019). This indicates that the number of studies in the implementation of the DLP on mathematics education for secondary school students produced in 2019 was many compared to other years. The increase in 2017 to 2019 indicates that researchers were interested in studying in this field. Specifically, there were only four DLP implementation studies for secondary school students conducted (14%) in 2017 (e.g., Arikan et al., 2017; Swanson et al., 2017), five studies (18%) in 2018 (e.g., Friedman-Sokuler & Justman, 2020; Justman & Méndez, 2018), six studies (21%) in 2020 (e.g., Borgonovia & Ferrara, 2020; DeVries et al., 2020), and five studies (18%) in 2021 (e.g., Liu & Bradley, 2021; Yılmaz et al., 2021).

Table 2. Thematic Analysis Based on the Articles Was Reviewed

No	Author	Year Publication	Country	Research Location	Design Method	Research Instrument	The Role of Language for Mathematics Education
1	Pierson et al.	2021	United States of America	Rural	Mixed methods	Test, Interviews, Observation	Assist students in learning involving Science, Technology, Engineering and Mathematics (STEM)
2	Tai & Wei	2021	Hong Kong	Urban	Qualitative	Interviews, Document Analysis	Improve students' skills and motivation
3	Zahner & Wynn	2021	United States of America	Urban	Qualitative	Interviews	Uses involving linguistic assignments that shape student reasoning in Mathematics assignments
4	Yılmaz et al.	2021	Turkey	Urban & Rural	Qualitative	Interviews, Document Analysis	Accessing references
5	Liu & Bradley	2021	United States of America	Urban & Rural	Mixed methods	Questionnaire, Interviews, Document Analysis	Reduce the gap between students
6	Suliman et al.	2020	Malaysia	Urban & Rural	Quantitative	Questionnaire, Document Analysis	Improve students' skills and motivation
7	Attar et al.	2020	Netherland	Urban & Rural	Quantitative	Questionnaire, Test, Interviews	Language in tests that affects performance
8	Tarasenkova et al.	2020	Ukraine	Urban & Rural	Quantitative	Questionnaire	Uses involving linguistic assignments that shape student reasoning in Mathematics assignments
9	Ibrahim & Alhosani	2020	United Arab Emirates	Urban	Qualitative	Interviews	Assist students in learning involving Science, Technology, Engineering and Mathematics (STEM)
10	DeVries et al.	2020	Germany	Urban & Rural	Quantitative	Questionnaire	Uses involving linguistic assignments that shape student reasoning in Mathematics assignments
11	Borgonovia & Ferrara	2020	Worldwide	Urban & Rural	Quantitative	Questionnaire, Document Analysis	Language in tests that affects performance
12	Maluleke	2019	South Africa	Rural	Qualitative	Interviews, Observation	Improve students' understanding of concepts
13	Schüler-Meyer et al.	2019	Germany	Urban	Mixed methods	Questionnaire, Test, Observation	Improve students' understanding of concepts
14	Ryan & Parra	2019	Sweden/ Colombia	Rural	Qualitative	Observation	Improve students' understanding of concepts
15	Albury	2020	Malaysia	Urban & Rural	Qualitative	Observation	Future use as marketability

Table 2. Continued

No	Author	Year Publication	Country	Research Location	Design Method	Research Instrument	The Role of Language for Mathematics Education
16	Cabezuelo & Pavón	2019	Spain	Urban & Rural	Quantitative	Questionnaire, Test	Language in tests that affects performance
17	Lavery et al.	2019	Worldwide	Urban & Rural	Mixed methods	Test, Document Analysis	Improve students' skills and motivation
18	Rattadilok	2019	China/ United Kingdom	Urban & Rural	Quantitative	Questionnaire	Future use as marketability
19	Burroughs et al.	2019	United States of America	Urban & Rural	Mixed methods	Test, Observation, Document Analysis	Language in tests that affects performance
20	Chronaki & Planas	2018	Worldwide	Urban & Rural	Qualitative	Narrative Analysis	Uses involving linguistic assignments that shape student reasoning in Mathematics assignments
21	Planas	2018	Spain	Rural	Qualitative	Narrative Analysis	Uses involving linguistic assignments that shape student reasoning in Mathematics assignments
22	Erath et al.	2018	Germany	Rural	Qualitative	Document Analysis	Language in tests that affects performance
23	Friedman-Sokuler & Justman	2020	Israel	Urban & Rural	Quantitative	Test	Language in tests that affects performance
24	Justman & Méndez	2018	Australia	Rural	Quantitative	Test	Assist students in learning involving STEM
25	Suliman et al.	2021	Malaysia	Urban & Rural	Quantitative	Questionnaire	Assist students in learning involving STEM/ Future use as marketability
26	Schüler-Meyer	2017	Germany	Urban & Rural	Mixed methods	Test	Improve students' understanding of concepts
27	Swanson et al.	2017	United Kingdom	Urban & Rural	Qualitative	Narrative Analysis	Language in tests that affects performance
28	Arikan et al.	2017	Austria, Belgium, Denmark, Finland, Germany, Netherland, Switzerland, Tukey	Urban & Rural	Quantitative	Test	Reduce the gap between students

Geographical Area Analysis

The second research question focused on the context of the study covered in the previous studies. Overall, Table 3 shows the distribution of geographical areas in the implementation of the DLP on mathematics education for secondary school students.

Table 3. Study Focus Area

Continent	Number of Articles	Percentage (%)
Africa	1	2
Asia	9	24
Australia	1	3
Europe	19	50
North America	4	10
South America	1	3
Worldwide	3	8

Table 3 shows the focus areas of the study conducted in the implementation of the DLP on mathematics education for secondary school students. The geographical area for this study had been divided into seven continents namely Africa, North America, South America, Asia, Australia, Europe and the rest of the world. Studies on the implementation of the DLP for secondary school students were mostly conducted in Europe (50%) (e.g., Attar et al., 2020; DeVries et al., 2020; Tarasenkova et al., 2020) and Asia (24%) (e.g., Suliman et al., 2020). The rest of the studies were conducted in Africa (2%) (e.g., Maluleke, 2019), North America (10%), South America (3%), Australia (3%) and Worldwide (8%) (e.g., Borgonovia & Ferrara, 2020; Lavery et al., 2019). The whole world is a study that involves a combination of several countries in one study. Specifically, Figure 3 shows the distribution of the countries which had conducted studies on the implementation of the DLP for secondary school students.

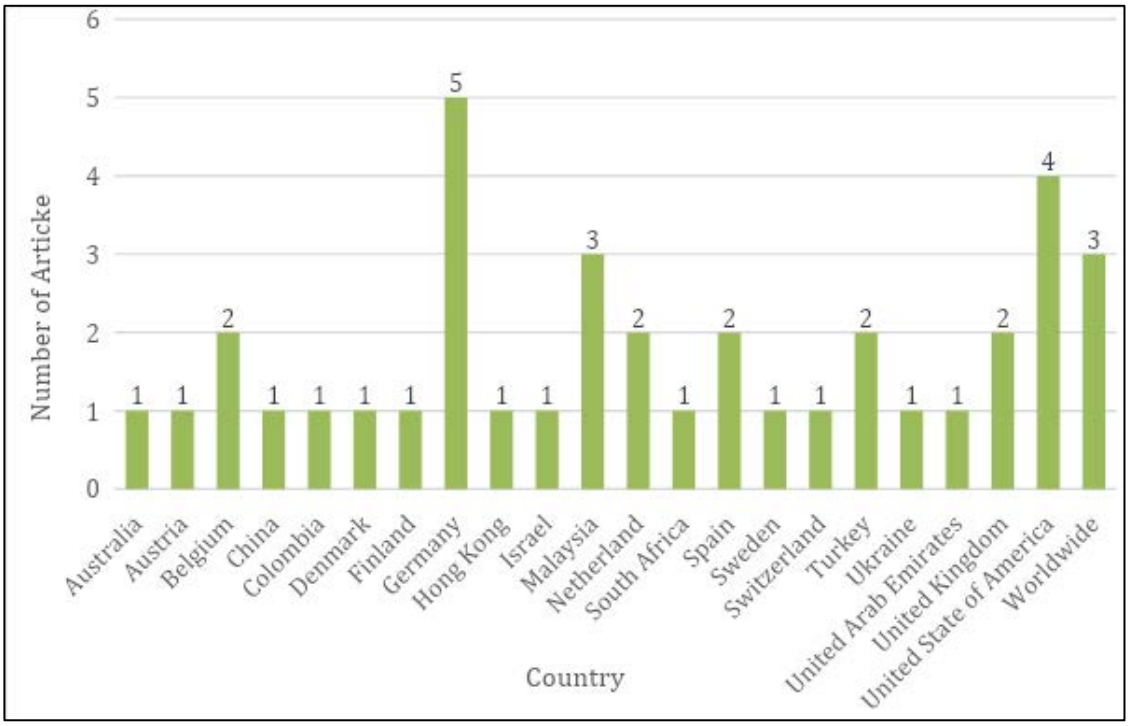

Figure 3. Distribution of the Study by Country

Figure 3 shows that Germany is the country which produced the most studies related to DLP (N = 5 or 13%) (e.g., DeVries et al., 2020; Erath et al., 2018; Schüler-Meyer et al., 2019). This was followed by the United States with studies of (N = 4 or 11%) (e.g., Liu & Bradley, 2021; Pierson et al., 2021; Zahner & Wynn, 2021). The rest of the studies were conducted in Malaysia and the rest of the world (N = 3 or 8%) as well as in the Netherlands, Belgium, Spain, Turkey and the United Kingdom (N = 2 or 5%). A very small number of studies had been conducted in South African countries, Australia, Austria, China, Colombia, Denmark, United Arab Emirates, Finland, Hong Kong, Israel, Sweden, Switzerland and Ukraine (N = 1 or 3%).

Research Location

The third research question focused on the research location. Overall, Figure 4 shows the distribution of study locations in the implementation of the DLP on mathematics education for secondary school students.

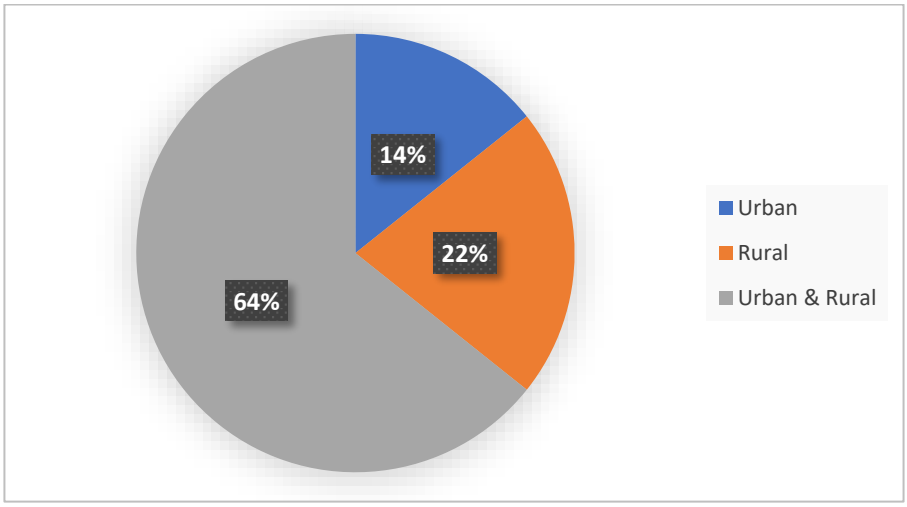

Figure 4. Distribution of the Studies Based on the Study Locations

Figure 4 shows the location of studies conducted in the implementation of the DLP on mathematics education for secondary school students. The study locations in this study were divided into three areas namely Urban, Rural and Urban & Rural. Most of the studies were carried out in Urban & Rural geographical areas. This is due to Urban & Rural (N = 18 or 64%) (e.g., Albury, 2020; Borgonovia & Ferrara, 2020; Yılmaz et al., 2021) and accounts for more than half of the entire research. Additionally, the findings showed that there were more studies conducted in rural areas (N = 6 or 22%) (e.g., Maluleke, 2019; Ryan & Parra, 2019) than studies in urban areas (N = 4 or 14%) (e.g., Ibrahim & Alhosani, 2020; Schüler-Meyer et al., 2019; Tai & Wei, 2021).

Research Design

The fourth research question focused on the research design of past research. Overall, Table 4 shows the distribution of study design in the implementation of DLP on mathematics education for secondary school students.

Table 4. Study design for Previous Studies

Research Design	Number of Articles	Author
Qualitative Method	11	Tai and Wei (2021) Zahner and Wynn (2021) Yılmaz et al. (2021) Ibrahim and Alhosani (2020) Maluleke (2019) Ryan and Parra (2019) Albury (2020) Chronaki and Planas (2018) Núria Planas (2018) Erath et al. (2018) Swanson et al. (2017)
Quantitative Method	11	Suliman et al. (2020) Attar et al. (2020) Tarasenkova et al. (2020) DeVries et al. (2020) Borgonovia and Ferrara (2020) Cabezuelo and Pavón (2019) Rattadilok (2019) Friedman-Sokuler and Justman (2020) Justman and Méndez (2018) Suliman et al. (2021) Arikan et al. (2017)

Table 4. Continued

Research Design	Number of Articles	Author
Mixed Methods	6	Pierson et al. (2021) Liu and Bradley (2021) Schüler-Meyer et al. (2019) Lavery et al. (2019) Burroughs et al. (2019) Schüler-Meyer (2017)

Table 4 shows the design of the study conducted in the implementation of the DLP on mathematics education for secondary school students. Qualitative study design (e.g., Ibrahim & Alhosani, 2020; Yılmaz et al., 2021; Zahner & Wynn, 2021) and quantitative design (e.g., Attar et al., 2020; Suliman et al., 2020; Tarasenkova et al., 2020) each had the same number of articles i.e. (N = 11 or 39%). Meanwhile, the combined study design of qualitative and quantitative was the choice in six articles (N = 6 or 22%) (e.g., Lavery et al., 2019; Liu & Bradley, 2021; Schüler-Meyer et al., 2019).

Research Instruments

The fifth research question focused on the type of research instrument used in the previous study. Overall, Figure 5 shows the distribution of research instruments in the implementation of the DLP on mathematics education for secondary school students.

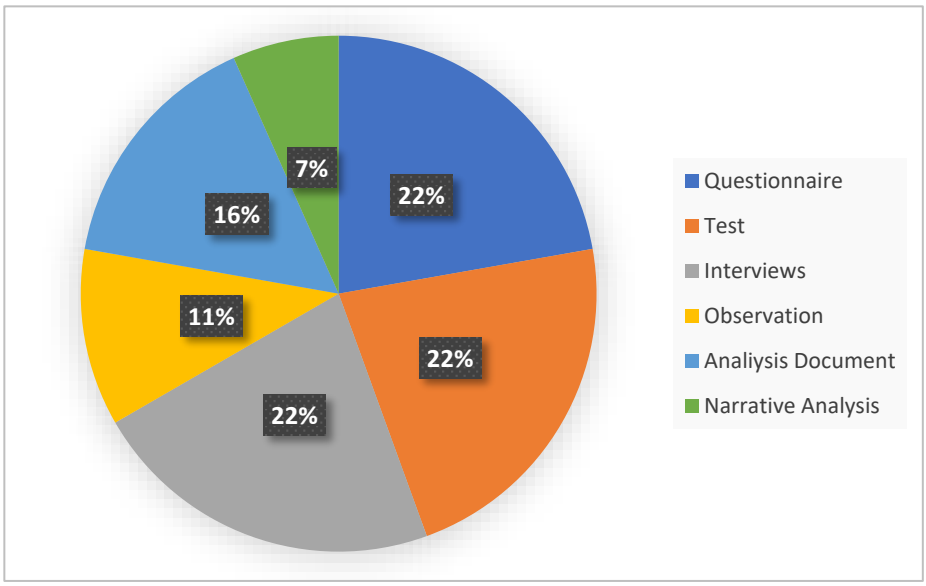

Figure 5. Study Instruments for Previous Studies

Figure 5 shows the research instruments in mathematics education for the studies conducted on the implementation of the DLP on mathematics education for secondary school students. Six types of research instruments were utilised in past studies. Questionnaires, tests and interviews each had the most number of articles and had the same number i.e. (N = 10 or 22%) (e.g., Burroughs et al., 2019; Rattadilok, 2019; Suliman et al., 2021). This was followed by other research instruments namely document analysis (N = 7 or 16%) (e.g., Erath et al., 2018; Lavery et al., 2019), observation (N = 5 or 11%) (e.g., Albury, 2020; Ryan & Parra, 2019) and narrative analysis (N = 3 or 7%) (e.g., Chronaki & Planas, 2018; Swanson et al., 2017).

The Role of Language in Mathematics

The sixth research question looked at the role of language use on mathematics education of school children. Overall, Figure 6 shows the distribution of the role of language for mathematics education in the implementation of the DLP on mathematics education for secondary school students.

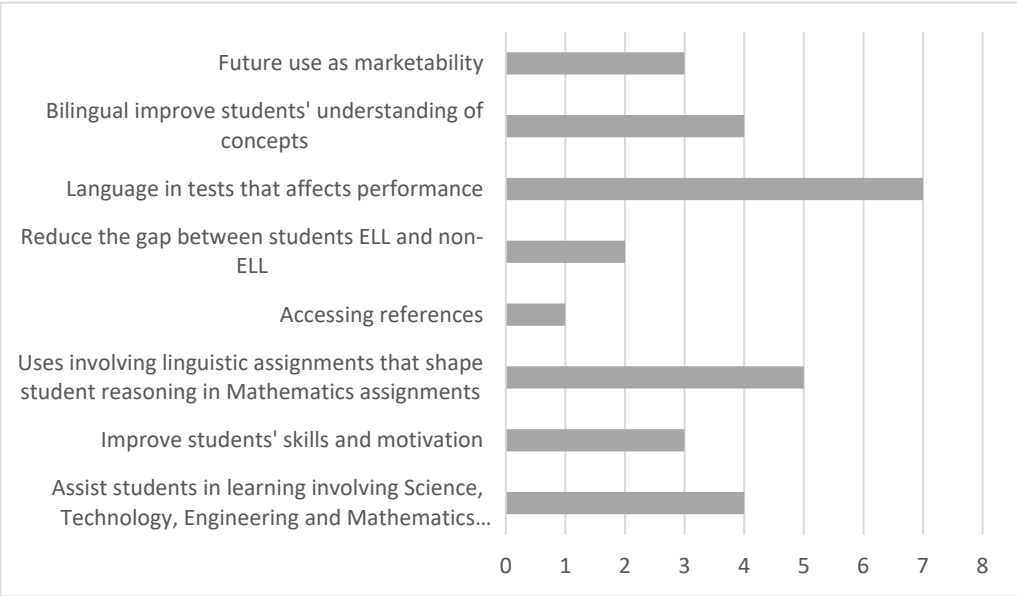

Figure 6. The Role of Language in Mathematics Education

Figure 6 shows the role of language in mathematics education for studies conducted on the implementation of the DLP on mathematics education for secondary school students. There were eight different language roles as a result of the study findings. The most widely used role in mathematics education was language in tests which influenced student performance in mathematics (N = 7 or 24%) (e.g., Cabezuelo & Pavón, 2019; Erath et al., 2018; Friedman-Sokuler & Justman, 2020). This was followed by the role of language as a tool that involves linguistic tasks which shape students' reasoning in mathematics tasks (N = 5 or 17%) (e.g., Chronaki & Planas, 2018; Planas, 2018). For the role of language to assist students in learning involving STEM and as bilingual to improve students' understanding of concepts in mathematics, this gained a value of (N = 4 or 14%) (e.g., Ryan & Parra, 2019; Schüler-Meyer, 2017). Next, the role of language as a second language or medium of instruction to improve students' skills and motivation in mathematics and future use as a marketability such as at the university level, workplace or identity skills had the same number of articles (N = 3 or 10 %) (e.g., Albury, 2020; Rattadilok, 2019). The rest of the language role was to reduce the gap between English (ELL) and non -English (ELL) students for use in mathematics (N = 2 or 7%) (e.g., Arikan et al., 2107) and for students to access mathematics-related references more widely (N = 1 or 4%) (e.g., Yılmaz et al., 2021).

Discussion

The findings of the study show that the trend of DLP research increased from 2017 to 2019. This indicates that the researchers were interested in doing research in the implementation of DLP on mathematics education for secondary school students. However, there was a downward trend for this research starting in 2020 to 2021 but this was not too significant. The findings of the study are in line with Khuziakhmetov et al., (2020) who stated that bilingual education itself is a leading field of educational policy in many countries of the world. This proves that DLP is very important in education, which is in line with Köktürk et al. (2016) who stated that bilingualism is largely accepted in society as providing significant advantages to human beings. Furthermore, Riordain and Mccluskey (2015) indicated that when students are involved in bilingualism for mathematics subjects, it is very important for students to address social problems of language use in context and not just the role of language in cognition.

The findings of the study indicate that continental Europe was the leader in the study of DLP implementation for secondary school students. Meanwhile, the countries which had produced many studies on the implementation of DLP for secondary school students are the United States and Germany. The findings show that there was a large gap in the implementation of DLP, especially for the geographical area between the continent of Europe and Asia as well as other continents. This is because research has been carried out in continental Europe amounting to half of all research volumes. The findings of this study are in line with Griskell et al. (2020) who stated that DLL public schools in the United States are on the rise. Additionally, according to Rumlich (2015), in Germany, a Content and Language Integrated Learning (CLIL) program involving secondary school students has been conducted for the past 15 years to create language proficiency among students in the future. CLIL is an approach to teach content learning through additional languages (foreign or second) and was created in 1994 by Marsh and Maljers (Šulistová, 2013). This is also in line with Prochazkova (2013) who stated that CLIL is an increasingly important trend in Europe in the field of education. This proves that most articles related to DLP were widely developed in the United States and Germany (the latter located in continental Europe),

For the third research question, the findings show that most of the articles in the study of DLP implementation for secondary school students were implemented in the Urban & Rural (Combined) areas. The number of studies conducted in rural areas was high compared to urban areas. The findings of this study support previous studies where it was found that language-related studies in mathematics education in rural areas were lacking (Renganathan, 2021). This suggests that most articles do not conduct studies using samples in rural areas, such as those conducted by Murphy (2019), Renganathan (2021) and Nordholm et al., (2020). Additionally, studies in rural areas were higher than in urban areas because students in rural areas received less verbal exposure in the language (Ganesh et al., 2019). Therefore, researchers were more interested in studying the implementation of DLP in rural areas. This statement was supported by past research (Yadav, 2019) which stated that mathematics education in rural areas needed more attention from certain parties so that mathematics achievement for students can be improved.

The findings of the study stated that the study design in the DLP implementation study for secondary school students was balanced between qualitative research and quantitative research. On the other hand, the mixed methods approach was less popular compared to qualitative study and quantitative study. The findings of the study were in line with those of Schüler-Meyer et al. (2019) because various positive effects from previous studies had been identified qualitatively. Additionally, according to Prediger et al. (2019), a qualitative study is suitable for use in bilingual implementation of mathematics subject for better explanation. A descriptive research study is a quantitative study involving data collected from the entire population and the general analyses used are frequency, percentage, mean, standard deviation and distribution of scores in presenting the report (Ang, 2016). This indicates that qualitative and quantitative methods are needed for the study of DLP implementation in mathematics education.

Finally, the findings of the study show that the role of language on mathematics education was the most widely used in the study of DLP implementation for secondary school students as the language used in tests that affect student performance in mathematics. The findings of the study further strengthen the study of Shanmugam and Lan (2013), who stated that the test in bilingualism was an effective accommodation test to measure student achievement in mathematics. Additionally, according to Giraldo (2018), language assessment exercises were used in tests to improve teaching and learning. These cross-linguistic differences can affect, in many ways, ELL's ability to decode and spell in English, interfering with academic language proficiency achievement (Shatz & Wilkinson, 2010). According to Farrell (2011), highly proficient students in both languages perform best in physics and mathematics examinations.The findings also further strengthen the findings of Han and Ginsburg (2001) on student achievement which showed that Chinese-speaking and bilingual groups got higher marks on special mathematics test than English-speaking students.This proves that language also has an important role in testing that is able to influence student performance.

Conclusion

The findings of the study have concluded that there is a frequency of articles issued related to the implementation of DLP in secondary school mathematics education. Based on the study findings, a total of 28 articles were released during 2017 to 2021. The findings of the study showed that most of the production of articles related to the implementation of DLP in secondary school mathematics education from 2017 to 2021 were from continental Europe. Countries located in continental Europe are Austria, the Netherlands, Belgium, Denmark, Finland, Germany, Spain, Sweden, Switzerland, Ukraine and the United Kingdom. The findings of the study stated that the implementation of DLP in secondary school mathematics education during 2017 to 2021 was mostly conducted in the Urban and Rural areas (Combined). The findings of the study indicated that most of the produced articles related to the implementation of DLP in secondary school mathematics education utilised the qualitative study design and quantitative study design. The findings of the study also provide information related to most of the production of articles on the implementation of DLP in secondary school mathematics education using research instruments such as questionnaires, tests and interviews. Finally, the study findings showed that information of the production of articles related to the implementation of DLP in secondary school mathematics education mostly described the definition of language as the language used in tests that affect student performance in mathematics.

Recommendations

Based on the findings, we discover that the year of publication of articles related to the implementation of DLP for secondary school mathematics education has decreased from 2020 to 2021. Therefore, it is hoped that there will be more studies related to the implementation of DLP in mathematics education, especially related to the bilingual cognitive aspects of students and language use when involved in conceptual mathematics activities (Riordain & Mccluskey, 2015). It is hoped that the recommendation of bilingual-related studies in mathematics education broadly will contribute to more inclusive teaching and learning of mathematics (Robertson & Graven, 2019). Based on the findings of the year of publication of articles related to the implementation of DLP for secondary school mathematics education, the continent of Africa, South America and Australia produced the least number of articles. A suggestion for further study would be to intensify the production of articles on the continent as follows. According to Ester et al. (2021) for any education system, it is quite challenging to know how to work in linguistics and the context of cultural diversity to improve the process of teaching and learning mathematics. Yet, bilingualism has been the focus of systematic research and discovery only in the past few decades and the results have changed the way society views

bilingualism and its needs in today's world (Elezi, 2015). Findings of studies related to the implementation of DLP in mathematics education indicate a lack of studies in urban areas. Some studies indicate that rural schools generally have lower equipment and infrastructure than urban schools mainly due to location and funding (Perman, 2021) as well as due to lack of resources, rural school students do not have adequate access to education compared to school children in the city (Khanal, 2016). Nevertheless, urban location studies are also important in order to reduce the disparity gap between rural and urban school students as policymakers should remember that educational improvement initiatives must consider differences in socioeconomic student composition (Rodrigues et al., 2021). Therefore, the next research proposal is to enhance research related to the implementation of DLP in mathematics education in urban areas.

Findings of studies related to the implementation of DLP in mathematics education indicate that the mixed method approach is lacking. The next study proposal is that the design of the combined study should be augmented. This is because according to Zainudin et al. (2016), the mixed method approach is a more complete integration and synergy of data use than separating data and making analysis separately. Findings of studies related to the implementation of DLP in mathematics education indicate that narrative analysis research instruments are lacking. For further research, it should be suggested that the narrative analysis research instruments are multiplied. This is because narrative analysis is important to understand the meaning that individuals attach to their experiences and to structure daily routines, categorize values and hide undesirable aspects of social life (Mura & Sharif, 2017). This is in line with the implementation of DLP in mathematics education for secondary school students who have experience of bilingual use in mathematics education. Riordain and Mccluskey (2015) stated that bilingual implementation in mathematics helps students use both languages independently and depending on the context/purpose. Thus, students are able to use bilingual privileges independently and gain an advantage in accessing mathematics-related references.

Limitation

There are significant limitations to this SLR, and more research on how DLP affects mathematics achievement with a different treatment strategy is needed. Scopus and Web of Science were the only databases utilized within the last 5 years. Due to their lack of accessibility to electronic information resources, certain publications may not have been involved in our data analysis. These are also the most well-known databases in academic subjects. However, we were able to stick to a strict search and selection method. Moreover, we might have limited the keywords like ("mathematics education" OR "mathematics achievement" OR "mathematics accomplishment" OR "mathematics competency" OR "mathematics") AND ("dual language program" OR "bilingual" OR "english language proficiency"). Some researchers were found to employ dual language immersion (DLI), which refer to DLP. This, however, might have resulted in some selection bias or the omission of potentially significant treatments. Manual screening may be able to assist in resolving this issue. Again, if an article did not match the criteria, it was removed from consideration. Proceedings, conferences, newspaper clippings and books, for example, are excluded. Even though the present literature review's study objectives directly relate to the issue of DLP implementation in the context of mathematics education, research findings solely concentrate on role of DLP toward learning outcome. This raises the issue of what obstacles children, instructors, and parents face that are yet unknown.

Authorship Contribution Statement

Khaizaar: Conceptualization, design, analysis, writing. Hidayat: Analysis, editing/reviewing, writing, supervision.

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