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Generative Learning Strategy in Mathematics Education: A Systematic Literature Review

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Abstract

Generative Learning is a strategy that have become increasingly in year 2020 to year 2024 among learners to actively engage with the material to construct their own understanding. However, not many instructors use this strategy in teaching and learning process and need to expose to the proper way to execute this strategy in classroom. The objective of this article is to reveal a systematic literature review about generative learning strategies in Mathematics teaching and learning process by analyzing its trend in Generative Learning Strategy (GLS). The review processes included five main methodological steps, namely guided by review protocol, formulation of research questions, systematic searching strategies based on identification, screening, and eligibility based on several well-known electronic databases such as Scopus and Google Scholar. The review process was then followed by analyzing 21 articles that were brought to quality appraisal, data extraction and analysis. The findings showed how the generative learning affects individuals in learning process. These findings can be used as a reference for teachers to be implement these as learning strategies that can involve students' in cognitive aspects to enable meaningful learning. These findings also provide educators with insight into the information processing occurring in a person's cognition and reveal several learning strategies that align with information processing theory and also have the potential to guide future research in this field. The results of these findings are important source for teachers to improve Mathematics lesson in teaching and learning process, whereas researchers and policymakers to improve the quality of mathematics education.

Keywords Generative Learning Model, Generative Learning strategy, Mathematics education, teaching and learning strategies.

INTRODUCTION

Generally, there are many pedagogical models that have been used in education in teaching and learning process. The most common ones are traditional, behaviourist, social and constructivist models [1]. Traditional model refers to teacher as superior and act as main source of information in classroom. Behaviourist model is where learning is achieved when learners responds to stimuli in the environment through rewards and penalties. Social model. In the other hand, [1] also explains that social model is an approach that focuses on social aspects in learning like interaction and communication between the students unlike behaviourist model that acquire reinforcement of specific behaviours. Constructivist model mainly to construct knowledge through exploration and interaction [1]. Generative Learning Model is developed mainly to aid teachers to improve cognitive development in learners [2].

Generative Learning is an educational learning model whom was introduced by [3] and it is also derived from constructivism learning model [4]. In this model, cognitive structures are presented as a vital catalyst to link newly acquired information with their existed knowledge in the form of cognitive structure. This model can be implemented as a strategy in many fields. According to Wittrock's generative model [3], there are four main components to have a meaningful learning, which is a) generator, b) motivation, c) attention and d) memory. Firstly, generator is meant by the connection between information knowledge that have been already existed and new information knowledge that will be learnt by learners. Secondly, motivation refers to student's readiness in gaining a lesson. Thirdly, attention refers to the relevant knowledge learnt by the learners and lastly, memory component is where learners' prior knowledge, experience and beliefs about the material. This generative learning provides an active learning environment for learners in the process of gaining new knowledge [5]. In short, Generative Learning focuses on cognitive function where learner integrate new knowledge to existing information, whereas Behaviorist model mainly about external factors in shaping behaviour and social and Constructivist models gives priority to interaction in the learning process. In this review, generative learning will be primely focuses of the skills that are obtained in implementing generative learning in teaching and learning process. It is believed that generative learning model could motivate students, promote constructive mindset and elevates students' academic performance [2]. Thus, there is a need to conduct a systematic literature review regarding this model on how it was implemented in mathematics education so that it will be a guidance for an upcoming study in future related to mathematics education.

In the past studies, we can see that generative learning have been applied to many Mathematics topics like Geometry, Pythagoras Theorem, Trigonometry, Circle, Fractions, Logarithm Equation, Probability, Algebra and Straight line to determine the effectiveness of implementing generative learning as a learning strategy or modified model in teaching and learning process [6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18]. These amount of studies needs a proper systematic literature review to analyze the findings of the past studies accordingly in order to be understand easily. In the other hand, there are also other types of learning strategies such as discovery learning and inquiry-based learning that have been used to improve student's mathematical ability and skills [19, 20]. Although other types of learning strategies have been used in effort to increase student's achievement and understanding in mathematics, but there are still some things lacking in these studies like, lack or specific questions to students, and students are unable to generate new ideas on own. That is why these problems can be overcome by using generative learning. At the same time, there are also other types reviews that have been conducted apart from generative learning strategies in mathematics education like problem-based learning [21, 22] where they have highlighted the need of more review in terms of thinking skill ability and mathematics literacy is still low. In this study, the authors will identify and analyze research focus according to the effects of generative learning strategy in teaching and learning mathematics.

Mathematics is one of the subjects that is very important nowadays. Mathematics education have been taught variously from primary to university levels. One of the main objectives in learning mathematics is to ensure that students can solve mathematics problems including the ability to understand problems, design mathematics models, solve models and interpret the solutions [23]. In the context of mathematics, efficient storage of gained information is required so that this information can be accessed again if needed like in a situation where students face problems that require a solution [4]. Thus, in order to achieve this objective, it is important to look at the recent studies in making decisions in how to implement a strategy in mathematics education. In this study, a systematic literature review has been carried out to identify the methodology used and trends in implementing generative learning as a strategy in mathematics education systematically. It is important to carry out systematics literature review because traditional literature review have several issues like author bias, retrieval bias and publication bias in where we can overcome these through a proper systematic literature review [24, 25]. Moreover, in past studies, there is none cases of systematic literature review have been conducted about generative learning especially in mathematics education. This proves that there is a significant in carrying out systematic review to improve the teaching and learning method in mathematics education.

METHODOLOGY

In this section, there are five key issues: 1) the review protocol, 2) formulation of research questions, 3) systematic searching strategies, 4) quality appraisal and 5) data extraction and analysis.

The review protocol-PRISMA

In this systematic literature review, PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analysis)* protocol were used in this study as a guide. PRISMA protocol have been used in various fields and have been chosen as the main reference due to its methodological clarity and comprehensive search strategy [26]. Then, the author also has outlined the systematic search strategy that focus on three steps as stated in [27]: 1) identification, 2) screening, and 3) eligibility. Finally, the author followed with analyzing the quality of the selected articles by explaining the steps taken to meet the quality standards and reported on how to extract and analyze data for the review based on the chosen articles.

Formulation of research questions

In this study, the research questions were formulated based on PICo framework. According to [28], PICo is known as mnemonics that is used to structure research questions based on three main concepts which is P (Population/Problem), I (Interest), and Co (Context). Thus, with the aid of these three main concepts, several research questions were formed in this systematic literature review (see **Table 1**).

Hence, four research questions have been developed for this systematic literature review:

1. What is the distribution of study based on year of publication?
2. What is the distribution of study based on research methodology?
3. What is the distribution of study based on research approach?
4. What is the research focus that has been used in previous studies of the implementation of generative learning in mathematics education?

Table 1 Three Concepts of PICo

Search Database	Definition	In this study
Population (P)	What are the characteristics of the population?	Mathematics students or teacher in Mathematics subject.
Interest (I)	What are the phenomena of interest?	Implementation of generative learning in teaching and learning of Mathematics subject.
Context (Co)	The particular settlings or areas of the population	Mathematics education

Systematic searching strategies

The systematic search strategy consists of three primary steps: 1) identification, 2) screening and 3) eligibility as can be seen in ***Figure 1***.

Identification

In this part of review, to produce a good systematics research, three components need to be take into account such as evaluating the title, key words and abstract [29]. Thus, in this review the author has used four search engine database such as Scopus, Spring Link, Science Direct and Google Scholar to find the related reference articles. These search engine databases were preferred based on their advantages of stable searching source and inclusion of function button for advanced searching filtration [30]. Google Scholar also have been selected as one of the databases apart from having few weaknesses in terms of quality control [25] but [31] supports that Google Scholar contains more articles as reference and can be used as one of search engine databases.

Two main search techniques were used in searching reference in database (Scopus, Science Direct, Springer Link, Google Scholar) which is by advanced searching with the aid of Boolean Operator (AND, OR). Other than that, manual searching by using handpicking techniques were used to manually pick references form Google Scholar, Science Direct, Springer Link and Scopus database. Based on the research questions that were suggested above, three key words can be obtained which is “generative learning”, “generative learning model” and “mathematics education”. These keywords have been used to find the articles from the database of the four search engines (see **Table 2**).

Table 2 Search string for systematic literature review

Search Database	Search String
Scopus	TITLE-ABS-KEY (("generative" OR "generative learning" OR "generative learning model*") AND ("mathematics" OR "mathematics learning" OR "mathematics education"))
Springer Link	(("generative learning" OR "generative learning model") AND ("mathematics education" OR "mathematics teaching" OR "mathematics learning"))
Science Direct	(("generative learning" OR "generative learning model") AND ("mathematics education" OR "mathematics teaching" OR "mathematics learning"))
Google Scholar	(("generative learning" OR "generative learning model") AND ("mathematics education" OR "mathematics teaching" OR "mathematics learning"))

The search process in Scopus, Springer Link, Science Direct and Google Scholar databases yielded a total of 2,294 articles, where 747 articles retrieved from Scopus database, 84 articles from Springer Link database, 23 articles from Science Direct database and 1,400 articles from Google Scholar database for collected. The authors then screened all 2,923 articles automatically in the database by using the sorting function based on the article selection criteria proposed by [32]. This is because it is long-drawn-out process to read through all previously published articles, thus, the authors set a time limit for their review as suggested by [33]. About 2,294 articles were gathered as the result of identification stage from the database and will be continued in screening stage that includes analyzing title, key words and abstract from the articles.

Screening

In this screening stage, the authors have limited the article published year range from 2020 to 2024 to ensure the articles are latest, relevant and appropriate to the current situation. This is in line with [34] where a stretch of time can determine the study maturity of a concept retrieve from the database. Moreover, searches in major databases can be seen a significant surge in the number of publications related to generative learning strategy. Once the screening process is completed, 2,204 articles were rejected because it did not meet the criteria that have been fixed and the rest of the 90 articles will be brought to the next process which is eligibility determination.

Eligibility

In this stage, the 90 articles that were selected from the previous stage will be undergoing screening stage for the second time to ensure the selected articles are relevant with the aim of this systematic literature review. In this process, the author will be screening the eligibility of the articles from the article's title and its abstract that yields 42 articles to be selected for next stage. If the decision of the chosen articles were relevant or not still fails to be obtained after reading the title and abstract of the study, then the methodology, results and discussion section of the article will be referred to by the author (see **Table 3**).

Table 3 Inclusion Criteria and Exclusion Criteria

Inclusion	Exclusion
5 years period (2020-2024)	Below year 2019 were excluded
Journal Articles	Non-journal articles
Articles published in English	Articles not published in English
Articles that focuses on the implementation of generative learning in mathematics education.	Articles that discussed about the implementation of generative learning in non-mathematics education related field.

About 21 articles were excluded from the 42 articles from the screening stage that yields 21 articles to be brought to quality appraisal process on the remaining articles. This stage is essential in order to make sure the selected article's methodology and analysis are suitable for this SLR. The authors make sure that the selected articles have research questions and are capable of answering the research questions. Perhaps, with the assistance of co-authors, the corresponding author then assessed the methodology and analysis part of the chosen articles to ensure those articles are in mutual agreement.

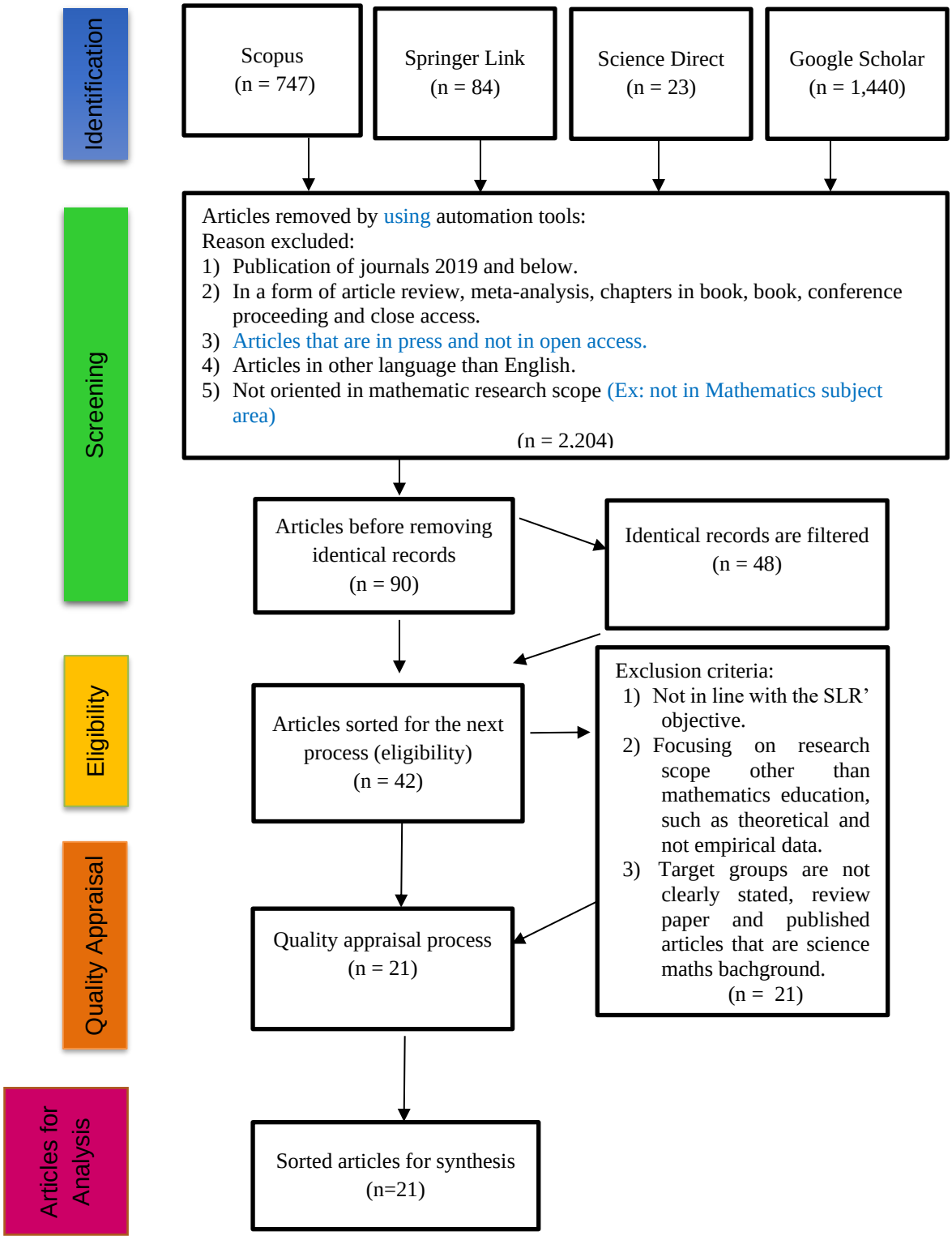

Figure 1 Flow diagram of the searching process (Adapted from Shaffril et al. [26]).

Figure 1 shows the flow diagram of the searching process by the authors to extract the related articles for this systematic literature review. The articles that have been selected for data extraction were reviewed at three main parts in article which is abstract, findings and discussion of the study. The extracted data were tabulated according to its criteria and were carried out analysis of data based on the 21 articles that have been sorted for analysis.

RESULTS

A sum of 21 articles have been used to answer four research questions after using PRISMA protocol. The chosen articles have been analyzed systematically with thematic analysis. There are four research questions, which is a) What is the distribution of study based on year of publication? b) What is the distribution of study based on research methodology? c) What is the distribution of study based on research approach? and d) What is the research focus that has been used in previous studies of the implementation of generative learning in mathematics education?

Table 4 Year of publication of the study

Author	Year	Research by Country	Research Sample	Approach of study	Instrument of the study					Research focus	How GL is implemented in Mathematics lesson?
					IV	D	T	O	Q		
Wardono et al.	2020	Indonesia	Student	Mix Method	/	/	/		/	Communication skill	Used with teaching aid.
Sutrisno & Kharisudin	2020	Indonesia	Student	Mix Method	/		/	/	/	Problem Solving Ability	Integrated as Mathematical Modeling Strategy (MMS)
Kusairi et al.	2020	Indonesia	Student	Quantitative			/			Problem Solving & Thinking skill	Used with students worksheet
Kirisci et al.	2020	Turkey	Student	Quantitative			/			Thinking skill	Used in lesson plan
Jusniani et al.	2020	Indonesia	Student	Quantitative			/			Communication Skills	Think-Talk-Write (TTW) learning model
Adeeko et al.	2020	Nigeria	Student	Quantitative			/			Conceptual Understanding	Used in lesson plan.
Al Mutlaq	2021	Saudi Arabia	Student	Quantitative			/			Thinking skills	Used in teaching process

continued

Jaelani	2021	Indonesia	Student	Quantitative			/		Spatial abilities	Integrated as SketchUp-aided generative learning (SAGL)
Lee et al.	2021	Singapore	Student	Quantitative			/		Problem Solving skills	Used in Constructivist Learning Design (CLD)
Hu et al.	2021	USA	Teacher	Qualitative		/		/	Feedback Strategies	Used in feedback strategies
McFeetors et al.	2021	Canada	Student	Qualitative	/	/	/		Learning strategy	innovative assessment approach: generative unit assessment
Minarti et al.	2021	Indonesia	Student	Qualitative	/			/	Communication Skills	Used in teaching and learning activities
Dewi et al.	2021	Indonesia	Student	Qualitative	/	/			/ Conceptual Understanding	Lecture-discussion forums
Dianti et al.	2021	Indonesia	Student	Qualitative			/		Learning strategy	Applied in class management
Kosiret et al.	2021	Indonesia	Student	Quantitative			/		Conceptual Understanding	Used in teaching process
Moma & Tamalene	2023	Indonesia	Student	Quantitative			/	/	Thinking skills	Used in learning process
Hulukati et al.	2023	Indonesia	Student	Qualitative		/	/		Communication Skills	Used in lesson plan
Evi Faujiah et al.	2024	Indonesia	Student	Quantitative			/		Thinking skills	Integrated as Generative Multi Representation Learning Model Modification Schema Based Learning (MGMRM-SBI)

continued

Hsu & Hsu	2024	Taiwan	Student	Quantitative	/			Learning strategy	Used imagination strategies in teaching
Akmam et al.	2024	Indonesia	Student	Mix Method	/	/	/	Thinking skills	Integrated as generative learning model based on cognitive conflict (GLBCC) model
Faujiah et al.	2024	Indonesia	Student	Quantitative	/			Thinking skills	Used in teaching process

IV= Interview, D= Document Analysis, T= Test, O= Observation, Q = Questionaire, GL= Generative Learning

Trend of study by year

Figure 2 shows the number of published articles from the year 2020 to 2024. It can be seen that the trend for the study related to implementation of generative learning in mathematics education increases from year 2020 to 2021 and decreased drastically to 0 in year 2022 and increases gradually from year 2023 to 2024. The highest number of articles published was in year 2021 which was about nine articles [7, 8, 9, 10, 11, 12, 13, 35, 36] from year 2020 to 2024 and there was no related research found in year 2022 regarding the implementation of generative learning specifically in mathematics education that suits this SLR. The peak in year 2021 was due interest of researchers to conduct study related to generative learning as a strategy in teaching and learning. This can be seen in the articles [6, 8, 9] focuses on implementing generative learning in teaching and learning process, articles [33, 37, 38] in integrating generative learning strategy with other learning strategies and [39,40] on evaluating students using generative learning strategy in classroom. Only one research in year 2021 conducted through online lessons due to Covid-19 outbreak [7]. Then, there is a notable increasing number of research study from year 2022 to year 2024 which are two articles and four articles respectively.

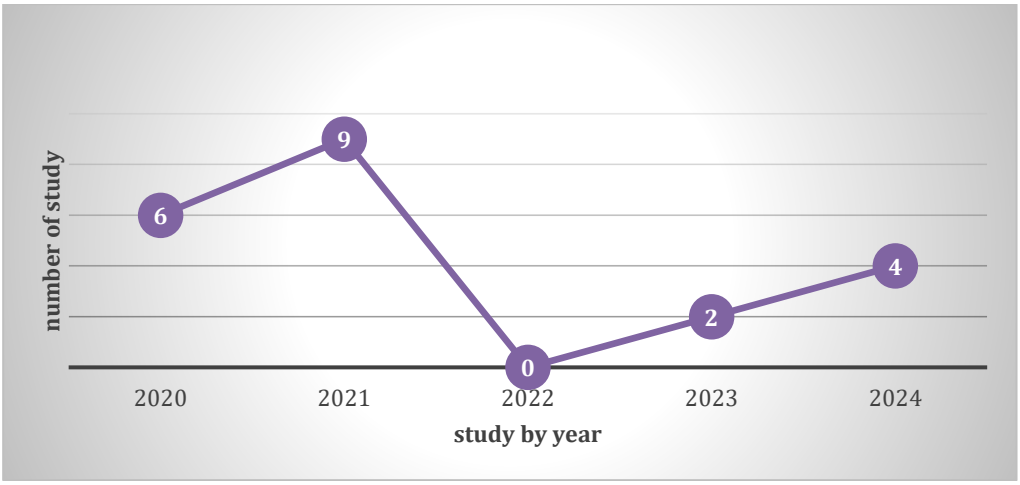

Figure 2 Publication years of selected studies

Countries of the study

From the 21 articles, a total of 14 papers focused their research in Indonesia [41, 37, 38, 40, 8, 10, 11, 12, 13, 18, 14, 15, 42, 16]. In the other hand, each research study also focused on Turkey [39], Taiwan [43], Nigeria [6], Saudi Arabia [7], Singapore [9], the United States (US) [35] and Canada [36]. Indonesian is among the country that published highest number of articles in generative learning in mathematics education field meanwhile the rest of the country published one study each country (see Figure 3). Figure 3 illustrates the number of studies conducted about generative learning in different countries. It can be seen that Indonesian researchers are very active in utilizing generative learning in mathematics education compared to Canada, United States of America, Singapore, Saudi Arabia, Nigeria, Taiwan and Turkey have only one study each. This shows that Indonesia contributing majority of studies while other countries exhibit minimal research activity for generative learning strategy in mathematics education.

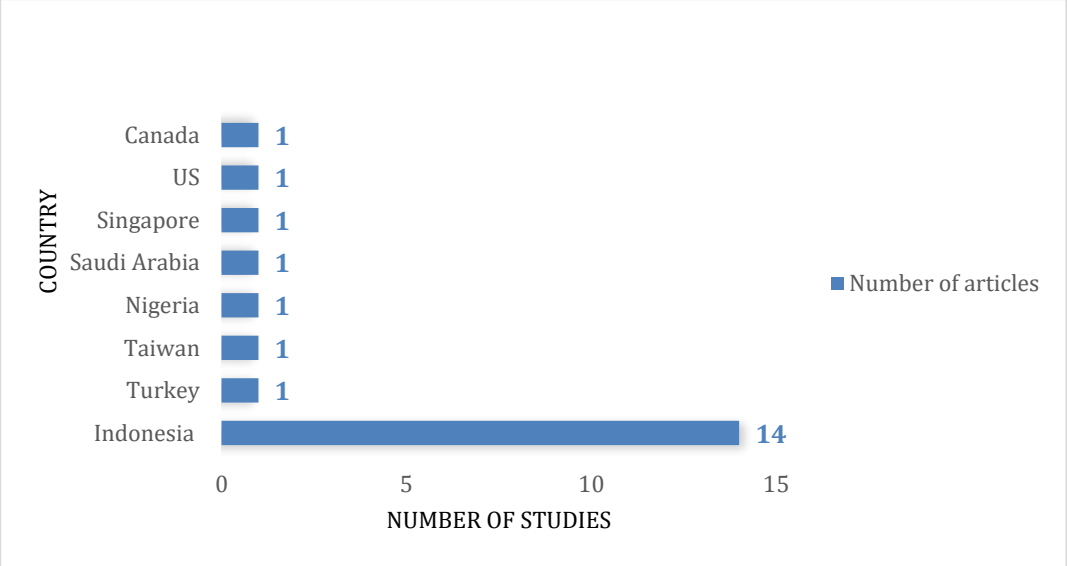

Figure 3 Countries where the selected studies were conducted

Research methodology of the studies

Regarding the research design, most of the articles are based in quantitative approach which is 13 articles [6, 7, 15, 16, 43, 35, 8, 40, 39, 13, 38, 9, 44] from data of year of 2020 to 2024, followed by qualitative approach five articles [11, 12, 35, 36, 10] and mix method approach producing three articles [42, 37, 41] (see ***Figure 4***). ***Figure 4*** illustrates quantitative methods dominates the research methodology followed by qualitative methods and mix-methods. This is because most of the researchers used test as their instrument to evaluate students' performance when implementing generative learning strategy in mathematics education.

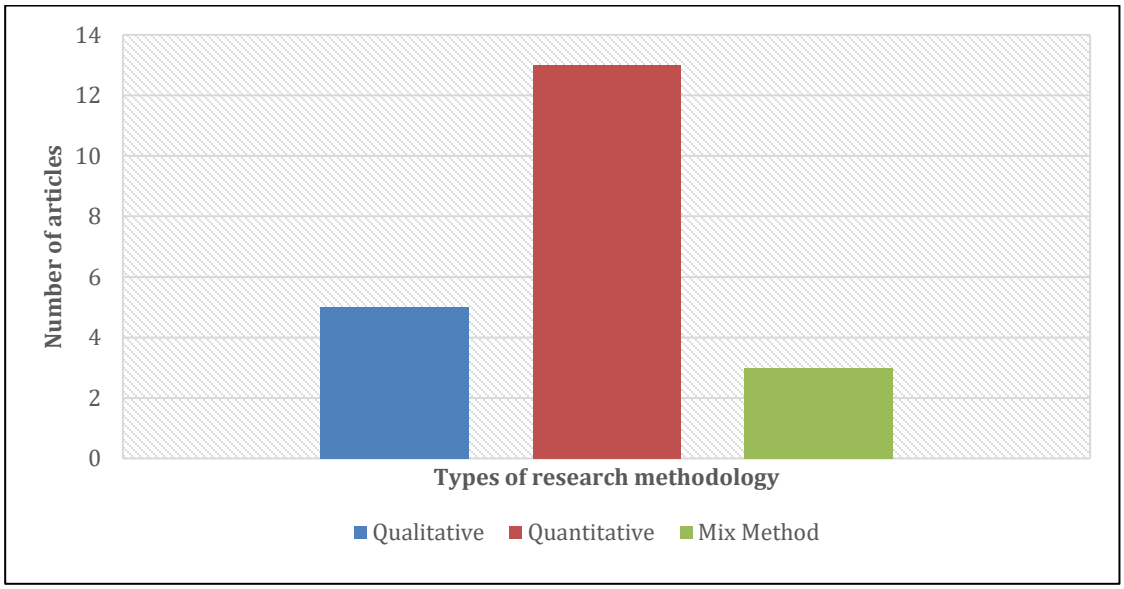

Figure 4 Research methodology of selected studies

Research Approach

Table 5 shows the analysis of research approach used for the three-research methodology. Based on this table, the highest number of research approach used from this 21 articles are quasi-experiment $(57\%, n = 12)$ on study [6, 7, 43, 8, 40, 39, 13, 38, 9, 44, 37, 41]. The second highest used research approach is action research $(19\%, n = 4)$ on four study [42, 12, 36, 10] is followed by experimental approach $(14\%, n = 3)$ of three articles [14, 15, 16] and case study $(10\%, n = 2)$ of twos articles [11, 35] respectively. Quasi-experiments were conducted in most of the studies by using quantitative methods or mix methods. This might be caused by more instruments used in qualitative method like interview, observations, document analysis need to carry out before analyzing data whereas quantitative methods only need two types of instruments like test and questionnaire which it is convenient to collect data from samples.

Table 5 Research approach used in the study

Study	n	Research Methodology			Research Approach				
		QL	QN	M	QE	CS	E	AR	S
(Wardono et al., 2020)	86			/	/				
(Sutrisno & Kharisudin, 2020)	41			/	/				
(Kusairi et al., 2020)	75		/		/				
(Kirisci et al., 2020)	201		/		/				
(Jusniani et al., 2020)	73		/		/				
(Adeeko et al., 2020)	96		/		/				
(Al Mutlaq, 2021)	58		/		/				
(Jaelani, 2021)	219		/		/				
(Lee et al., 2021)	41		/		/				
(Hu et al., 2021)	69	/				/			

continued

(McFeetors et al., 2021)	25	/				/
(Minarti et al., 2021)	25	/				/
(Dewi et al., 2021)	20	/			/	
(Dianti et al., 2021)	32	/				/
(Kosiret et al., 2021)	60		/	/		
(Moma & Tamalene, 2023)	99		/	/		
(Hulukati et al., 2023)	120		/		/	
(Evi Faujiah et al., 2024)	128		/		/	
(Hsu & Hsu, 2024)	244		/	/		
(Akmam et al., 2024)	138			/		/
(Faujiah et al., 2024)	64		/		/	

QL= Qualitative, QN= Quantitative, M=Mixed Method, QE= Quasi-experiment, CS=Case Study, E=Experimental, AR=Action Research, S=Survey, n = X participants

Research Focus

In order to answer the fourth research question, a total of 6 research focus from the 21 articles, have been identified such as students' thinking skills, students' communication skill, students' problem-solving skills, strategy, conceptual understanding and spatial ability (see Figure 5). About seven articles (32%) focused on their study about the implementation of generative learning towards students' thinking skill [42, 7, 15, 16, 38, 39, 44] which is the largest focused area of the effects of generative learning. Besides that, generative learning also have been used in four studies (18%) respectively to determine the effects of students' communication skill [14, 40, 10,41] and as a strategy (18%) in mathematics education [12, 43, 35, 36] followed by three articles (14%) regarding problem solving skills [38, 9, 37] and three articles (14%) in conceptual understanding [6, 11, 13] and one article (4%) about spatial ability of the students [8]. Moreover, one study have been highlighted with two research focus, which is problem solving skills and thinking skills [38].

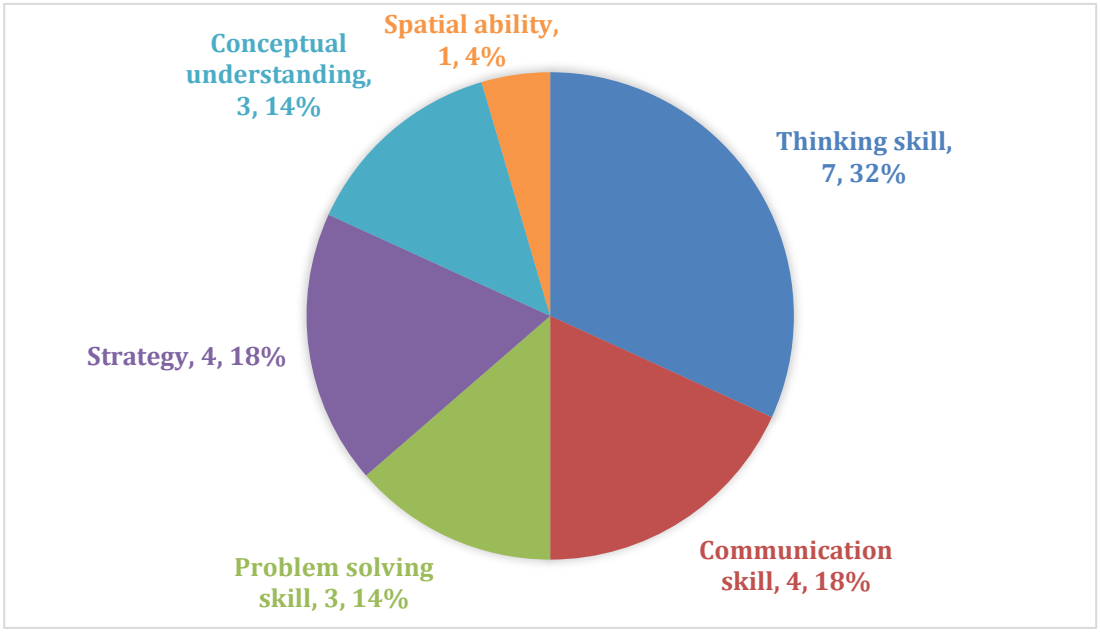

Figure 5 Research focus of the study

DISCUSSION

The purpose of this SLR is to explore the trend in implementing generative learning in mathematics education. The findings related to the generative learning study based on the year of publication show that the years 2020 and 2021 are the years with a high publication record. This shows that most of teachers and students have been actively integrating mathematics education with generative learning in teaching and learning process. Secondly, the results of the study also show that Indonesia is the most active country in publishing articles related to generative learning in the process of teaching and learning mathematics. According to [45,46] Indonesian student scores are still low in The Program International Student Assessment (PISA) and The Trend in International Mathematics and Science (TIMSS) specifically in Mathematics test. In fact, the results from United Nation Development Program year 2014 also highlighted that Indonesia ranked low 110 out of 187 countries in the world on the ranking of the Human Development Index (HDI) due to lack of reading comprehension ability [47]. Moreover, Indonesian students still needs improvement in mathematical literacy ability like ability to examine, reason, communicate, solve and interpret problems [48]. Thus, an effective learning model is needed to be implemented in classroom in order to excel in mathematics as suggested by [49]. Therefore, generative learning model have the criteria to foster students' ability to communicate mathematically that involves many students [41]. Hence, this shows how important the use of generative learning strategies is in mathematics education. In fact, it also proves that most of the teachers in this country use this strategy as a catalyst to excel in academic performance. This statement is in line with the study by [50] where generative learning will improve students' learning outcome in academic results.

Moreover, the results from the methodological aspect of the study show that most studies used quantitative research methods as their preference when studying about generative learning. This is because quantitative method is important when the study focuses on the effects of the implementation of generative learning as a strategy in mathematics education on student's achievement and motivation. In fact, academic test or assessment is one of the most commonly used instruments for quantitative method based on the past year study. In addition, findings based on the focus of the study deduce that most researchers use generative learning strategies to investigate students' thinking skills in learning mathematics. This in line with the definition of generative learning where, generative learning is used as a strategy to build a new conceptual knowledge to the existing information knowledge. Not only that, there are three main research focus that can be highlighted from this SLR. Generative learning strategy has an impact on three skills, namely thinking skills, communication skills and problem-solving skills. According to [32] generative learning that have been integrated with Schema-Based Instruction (SBI) in their study impacts the students thinking skill where this model is used in teaching strategy to enhance students' ability to use symbols in mathematical modeling, making predictions and generalize arithmetic patterns. This findings also in line with [9] that also integrates another model with generative learning which is selective problem solving model in lesson plans that improves students creativity of thinking level. Besides that, this modified model also help students to strengthen complex algebraic concepts in their study. According to [11], students ability to search for pattern in mathematical structures and the relationship also one of the impact of using generative learning as strategy in lessons. According to [25] generative learning strategy gives positive impact towards academic achievement and mathematics thinking skills in students that can be viewed in their test result.

A part from that, generative learning strategy also makes an impact in students communication skills such as better written mathematics communications when assisted by generative learning model and integrated with Think-Talk-Write (TTW model) [27, 33, 6, 36]. Thirdly, problem solving skills in students shows positive improvement when integrating with Mathematical Modeling Strategy (MMT), Constructivist learning and Generative Learning Model (GLM) in teaching and learning process [28, 29, 38]. However, there is still need future research to explore the effectiveness of generative learning in lower achieving students. Nevertheless, these findings are only based on 21 articles that were selected in the recent five years back of study that mainly focus on generative learning strategy in mathematics education. Although [30] recommended 14 databases that

have high sensitivity in finding resources, however in this SLR only two databases have been chosen, namely Scopus and Science Direct. Also, other databases such as Springer Link and Google Scholar have been used by the author. Other than that, due to time constraints, the articles that were analyzed consisted of articles that met the required criteria only [44].

CONCLUSION

Based on the 21 articles that have been selected for SLR, it can be concluded that generative learning does gives positive impact to student's achievements. Therefore, it is recommended to be used by teachers and learners as a teaching strategy in teaching mathematics. It is also recommended to use generative learning strategies in lesson plan, integrate visualization techniques to enhance conceptual understanding, and also integrating generative learning with interactive activities like collaborative activities in classroom to boost students thinking and understanding of mathematical concepts. Perhaps exploring in generative learning strategy with Artificial Intelligence (AI) like gamified generative learning approach may enhance generative mathematical thinking among students towards academic. In fact, future research across cultures with different learning traditions and educational policies in Western, Asian and other regional educational system should be compared to known the depth of effectiveness in the usage of generative learning. Though, generative learning is proven in giving impact in students achievement and skills, but researchers also need to bear in mind that the process of conducting generative learning may be time consuming throughout the teaching and learning process. Thus, these are the challenges in implementing generative learning in classroom settings. In this research, we can learn how generative learning can be implemented for teaching and learning mathematics in the classroom. Moreover, many previous studies have also proved that generative learning does gives a satisfying result in students' thinking skill, communication skill, problem-solving skill, conceptual understanding, spatial ability and as a strategy in teaching and learning process. This review also hopes that more teachers will continue to emphasize generative learning in classroom as it results in good academic achievements among the students.

LIMITATION AND DIRECTION FOR FUTURE RESEARCH

Most past studies only focus on the application of generative learning in mathematics learning without specifying the mathematics topics that have been used in details. Therefore, further analysis can be carried out for future studies to determine the connection between the topics and to the purpose of implementing this generative learning as their preferred strategy in mathematics education. From this review, it can also be seen that most of the study used quantitative as their research method, where most of them implementing the quasi-experiment approach and thus it is recommended to have more qualitative research method on future studies, such as observation and interview. Perhaps most of the data interpreted in this review are mostly based on Indonesian based study, which mean most of the data is heavily influenced by Indonesia's data. Thus, generalizations could not be made based on one country dominant data. Hence, it is encouraging for more countries to conduct further research in generative learning especially in Mathematics education. In fact, excluding non-English studies might affected the findings because large quantities of articles were removed in the screening process. If that data were in English language, then it might be useful to support the findings of the study and also might increase the quantities of articles to be reviewed.

In addition, the articles reviewed in this study are retrieved from databases such as Scopus, Science Direct, SpringerLink and Google Scholar only. There are also other databases such as Web of Science have been excluded from search strategy. This may limit the access to high-quality and up-to-date articles which could impact the outcomes from the study. Thus, future studies may include Web of Science database when conducting systematic literature review. Moreover, more research regarding meta-analysis method about

effectiveness of generative learning strategy in mathematics education is needed, plus various research methods also lacking in previous study and it is hoped that more further studies can be carried out in the context of mathematics education in our country.

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