Beta: Jurnal Tadris Matematika, 14(2) 2021: 154-174
DOI 10.20414/betajtm.v14i2.464

Research articles

Mathematics education research in Indonesia: A scoping review

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Abstrak Penelitian ini bertujuan untuk mengkaji penelitian pendidikan matematika di Indonesia dalam tujuh tahun terakhir. Pencarian pada jurnal level 1 dan level 2, yang dipilih melalui basis data nasional (Sinta), menghasilkan 595 artikel yang diterbitkan dari tahun 2015 sampai Maret 2021. Hasil konten analisis dari artikel tersebut menunjukkan bahwa penelitian paling banyak digunakan peneliti pendidikan matematika di Indonesia adalah kualitatif (41,85%), kuantitatif (32,94%), dan pengembangan (17,82%). Partisipan paling banyak dilibatkan adalah siswa SMP (35,63%), mahasiswa atau calon guru (23,87%), dan siswa SMA (17,48%). Sebagian besar jumlah sampel yang digunakan berada pada kisaran 31-60 orang (26,72%). Pengumpulan data banyak dilakukan melalui tes, wawancara, dan kuesioner. Sementara itu, analisis data paling banyak menggunakan statistik deskriptif, metode kualitatif, dan uji-t. Terdapat dua belas topik paling banyak diteliti di Indonesia, diantaranya; kemampuan matematis (27,23%), aplikasi teknologi (13,28%), dan proses kognitif (9,92%). Beberapa topik yang belum banyak berkembang di Indonesia yaitu filosofi dan sejarah pendidikan matematika, pembelajaran matematika anak usia dini, dan topik terkait multikultural, multilingual, dan kesetaraan dalam pendidikan matematika. Sementara itu, integrasi nilai-nilai Islam dalam pembelajaran matematika merupakan topik penelitian yang menjadi ciri khas di Indonesia.

Kata kunci *Topik studi, Penelitian pendidikan matematika, Tinjauan ruang lingkup, Indonesia*

Abstract This scoping review aims to examine mathematics education research in Indonesia in the last seven years. A search on top 1 and 2 journals, which were selected through a national database (Sinta), yielded 595 articles published from 2015 to March 2021. A content analysis of the articles revealed that research mostly used by mathematics education researchers in Indonesia was qualitative (41.85%), quantitative (32.94%), and developmental (17.82%). The research participants were dominated by junior high school students (35.63%), college students or pre-service teachers (23.87%), and senior high school students (17.48%). The number of participants ranges from 31 to 60 (26.72%) in the majority of the research. Most of the research data were collected through tests, interviews, and questionnaires. Meanwhile, in analyzing the data, the use of descriptive statistics, qualitative methods, and t-tests were obtrusive. There are twelve most researched topics in Indonesia, including mathematical ability (27.23%), technology application (13.28%), and cognitive process (9.92%). Several topics that have not been developed in Indonesia are philosophy and history of mathematics education, early childhood mathematics learning, and topics on multicultural, multilingualism, and equity in mathematics education. Meanwhile, the integration of Islamic values in teaching and learning mathematics is a particular topic in Indonesia.

Keywords *Study topics, Mathematics education research, Scoping review, Indonesia*

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Introduction

Research topics in mathematics education are very diverse, one of which is indicated by publications in many conferences, such as ICME or PME. For example, 13th ICME had 54 groups of research topics (Kaiser, 2016). The research topics focus on various aspects of mathematics education, for example, learning mathematics based on age levels, the use of technology, cognitive processes, teacher professionalism, mathematics curriculum development, development of evaluation tools, socio-cultural integration, mathematics for children with special needs, and various multidisciplinary issues. Nowadays, mathematics education research can be viewed from distinct perspectives and dimensions such as sociocultural. Identification of the development of research issues in mathematics education is pivotal to understand the progress of the field as a research domain (Sierpinska & Kilpatrick, 2012), provide insight for early-career researchers in the field, and prepare for unprecedented situation. For instance, during Covid-19 pandemic, researchers in the field are more challenged to find innovations to a learning environment that limits students' social and physical interactions and even in a fully online setting.

Trends in mathematics education research have attracted researchers' attention. For instance, Hilton (1984) identified three main topics in mathematics education research; application of various learning models, integration with mathematical concepts, and the use of computers. More detailed research trends in mathematics education were reported by Romberg (2016), who grouped the researched topics into several categories, such as activity-based mathematics, instructional design, and evaluation of mathematics learning outcomes. The diversity of study topics does not only stand for the global context but also applies to the context of a particular region or country. A related study has been carried out in Korea. Mathematics education research in Korea is growing, and the study topics are quite diverse, such as learning ability, instructional design, curriculum, and textbooks. The most popular research methods in Korea are pedagogical analysis, case studies, and surveys (Pang, 2020). Similar studies were also conducted in Turkey (Ciltas et al., 2012) and South Africa (Adler et al., 2016).

Surveying research trends in mathematics education is very useful; one of them is to identify what aspects of the field have (not) been succinctly explored. Such efforts have been conducted in Indonesia but only relate to the development of certain topics such as; two decades of Realistic Mathematics Education (RME) in Indonesia (Prahmana et al., 2020), values and character in mathematics teaching and learning (Mahfudy et al., 2019), distance learning (Kusmaryono et al., 2021), and the integration of technology in mathematics education (Young, 2017). The progress of research issues in mathematics education in Indonesia has not been reported for at least the last ten years. Therefore, a scoping study is essential to review the trends of mathematics education research in Indonesia. It will investigate what designs and types of research mathematics education researchers mostly referred to, how research data was collected and analyzed, what characteristics of participants involved, and what topics were mostly or under-researched or a possible specific topic, which is peculiar to the country underlying its social, political or cultural backgrounds. For insiders, the current review will be a mirror to reflect upon 'how far the field go.' This will be a point of comparison to what has been achieved in other specific regions or the international community. For outsiders, the review will complement prior reads (e.g., Patahuddin, Suwarsono & Johar, 2018) about mathematics education in Indonesia.

Methods

Conducting a review that requires a mapping of many study topics determines the methods to be used. A systematic review is a developed method to explore research results (Page et al., 2021). Moreover, meta-analysis is a popular approach that focuses on examining a specific topic but it cannot cover evolving research topics. If the goal is to map study topics and the results are described in a research trend, then scoping review is a representative selection. It is a method that allows the discussion of all study topics with answers to simpler and more specific research questions (Arksey & O'Malley, 2005). Therefore, this research selected a scoping review, aiming to explore the trends of mathematics education research in Indonesia for two reasons. Firstly, this study was conducted to review the research in mathematics education in Indonesia without explaining the findings in detail. Secondly, it is intended to describe the findings and opportunities to develop potential studies that have not been explored. This study follows five stages of scoping review (Arksey & O'Malley, 2005); identifying research questions, identifying relevant articles, selecting articles, mapping data, and compiling, summarizing, and reporting results.

Identifying research questions

We identified related research questions as a guide in carrying out the scoping review. The results of discussions and reviews on several previous relevant studies (e.g., Adler et al., 2016) lead to a decision to focus on study topics, sub-topics, keywords, types and designs of research, characteristics and number of participants, data collection, and data analysis used in each article. Therefore, the determining research questions were (1) what are the types and designs of mathematics education research in Indonesia? (2) who are the participants in mathematics education research in Indonesia? (3) how are data collected and analyzed in mathematics education research in Indonesia? (4) what topics are widely researched in mathematics education in Indonesia?

Identifying relevant articles

The data sources in this study were articles published in the journals indexed by Sinta database (https://sinta.kemdikbud.go.id/), especially journals ranked 1 and 2. All journals in the database have been ranked 1 to 6. The first rank indicates a top-quality journal. The articles in the top one or two journals have an adequate peer-review with international readability because most of them are written in English (Prahmana et al., 2020). In addition, study topics in mathematics education in Indonesia can be easily traced through Sinta database. Sinta was first launched by the Ministry of Research, Technology, and Higher Education in 2017. It becomes a reference in analyzing research studies in various fields of science, including mathematics education. The emergence of Sinta as a complete indexation system in Indonesia makes it easier for researchers to analyze various (potential) research topics. Hence, we identified the relevant articles in the journals indexed by the database.

Selecting articles

After identifying the relevant articles in the ranked journals, the search was continued on journal pages that meet the criteria with the screening stage (Page et al., 2021). Before the search, the intended journals were identified and resulted in 4 journals with Sinta 1 category (ranked

first), and 18 with Sinta 2 category (ranked second). There are 8 journals with general education scopes and 14 journals with mathematics education scopes. Afterwards, the accreditation period for each journal was identified to determine the number of articles that meet the criteria. We classified the articles in the selected journals according to the accreditation period. The publication period is limited from 2015 to March 2021 to obtain the latest studies of the research topics analyzed, as well as Sinta database as an indexing system which was only released in 2017. Lastly, the selection of the articles was held based on two criteria; the articles contain the topic of mathematics education research and were published during the journal's accreditation period.

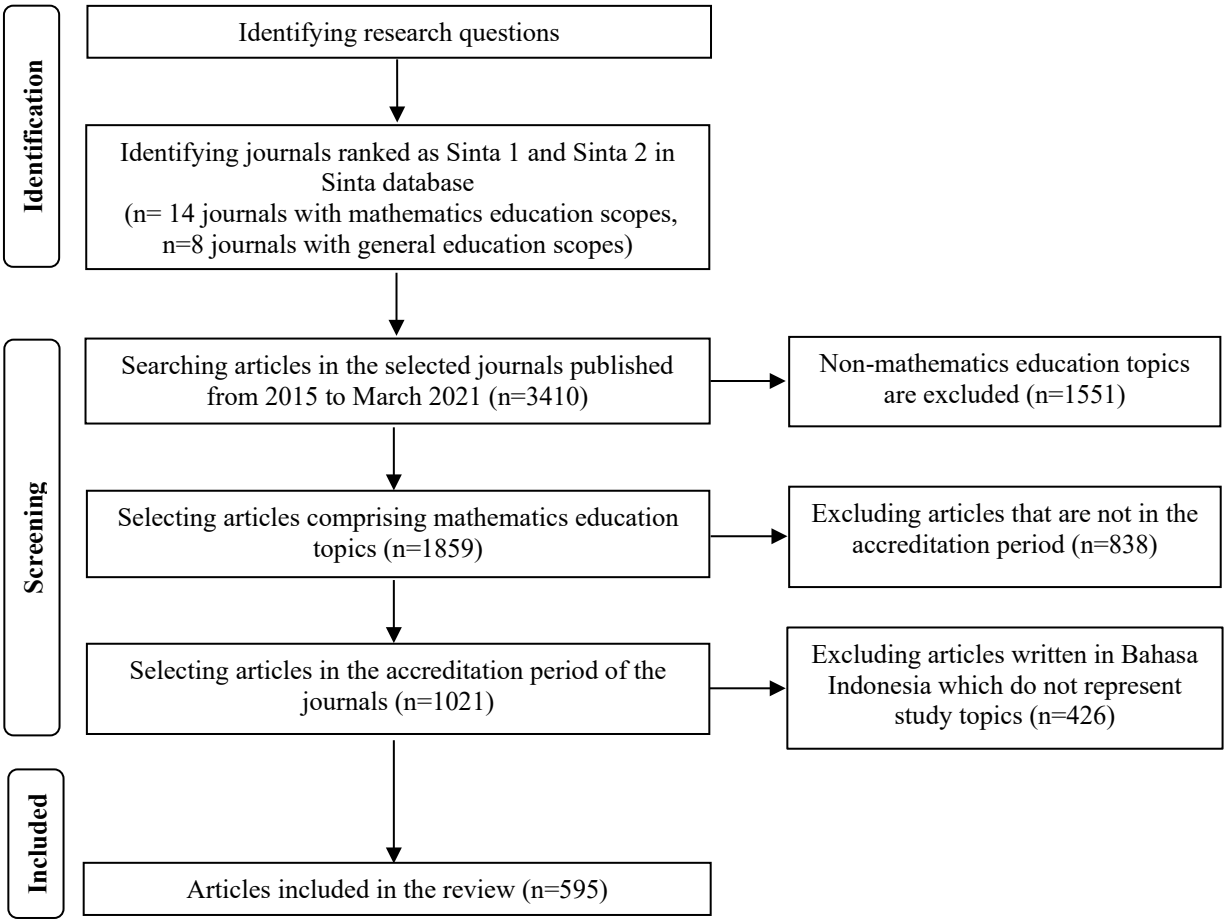

Figure 1. The flow diagram in selecting the articles for review

Researchers have an important role in deciding which articles to analyze, so they do not just depend on search engines. Results of the articles search were reported in the research team with layered checking techniques that can minimize subjectivity. Articles that have passed the selection or fulfilled the two criteria will be cross-reviewed by other team members to ensure all criteria have been met. Articles with topics of pure mathematics, science education, and general education that are not relevant to the study of mathematics education are screened for not being processed further. In addition, articles in journals that only use Bahasa Indonesia are discussed further to be selected based on the representation of the study topic. In this case, dual screening has the function of minimizing biased information and ensuring data accuracy (Page et al., 2021). The distribution of the selected articles analyzed for each journal in this study is shown in Table

1. The process of screening the articles is depicted in Figure 1 following PRISMA flow diagram (Page et al., 2021).

Mapping the articles

Information collected in the form of names and number of authors, year of publication, affiliation, research objectives, population or sample characteristics, methodology, and important findings of each article was used as material for discussion before being charted. Each information was tabulated in Microsoft Excel and visualized in the form of diagrams or tables. The grouping was done by examining the articles one by one based on the aforementioned categories. The results of the grouping were discussed, especially study topics that are considered overlapping or other information that is not written explicitly. The grouping articles were then analyzed based on content (Ryve, 2011); designs and types of research, research participants, number of samples, data collection, data analysis, research topics, and keywords. The articles were then analyzed and reviewed substantively on the findings to be grouped into research sub-topics. We analyzed the data manually without using software. The analysis was prioritized on significant parts of the articles like abstracts, methods, and conclusions. These three components are the fundamental part that contains all the significant information of an article.

Table 1. The articles distributed in the selected journals

No	Journal name	Sinta	Articles (n)	Publication years						
				2015	2016	2017	2018	2019	2020	2021
1	Cakrawala Pendidikan	S1	12	3		1	4	2	1	1
2	IJERE	S1	21				1	7	9	4
3	IJOST	S1	1							1
4	JME	S1	83		3	2	5	34	29	10
5	Elemen	S2	29						29	
6	IJE	S2	2						2	
7	IJEME	S2	64			16	16	14	11	7
8	Infinity	S2	52		7	5	3	4	22	11
9	JDM	S2	14						14	
10	JEST	S2	5					1	4	
11	BetaJTM	S2	30				8	11	11	
12	JIP	S2	2	2						
13	JPI	S2	12				3	3	6	
14	JPM	S2	45			2	4	16	15	8
15	JPP	S2	7				1	4	2	
16	JRAMathEdu	S2	35					4	25	6
17	JRPM	S2	51			3	10	19	19	
18	Kreano	S2	26						26	
19	Formatif	S2	10						7	3
20	Pythagoras	S2	9						9	
21	Aksioma	S2	44					4	40	
22	Aljabar	S2	41				2	9	30	
Total			595	5	10	29	57	132	296	66

Compiling, summarizing, and reporting the results

A narrative review approach was used to explain the analyzed content of the articles (Arksey & O'Malley, 2005). The charting results were presented in the form of tables or diagrams and then the quantities are compared. We described each article based on study topics, research designs and types, keywords, characteristics and number of participants, data collection, and data analysis. The mapped article content was then calculated manually. The research team cross-checked the collected data and checked the suitability of the content. After the number of articles on the mapped content were declared valid, the final data was shared with the whole team to discuss the reports. In this stage, the team focused on answering the research questions and reporting the results in a narrative way.

Findings and Discussion

Research designs and types

Qualitative research dominates the number of articles analyzed (41,85%), followed by quantitative research (32,94%), and development research (17,82%). Mix-method research accounts for 3,53%, while literature review and classroom action research are 2,18% and 1,68%, respectively. The most widely used research types are descriptive qualitative (22,86%), experiment (18,65%), cross-sectional survey (5,38%), design-based research (5,04%), explorative (4,71%), ADDIE model (4,03%), and Thiagarajan 4-D model (3,7%). The summary of the research designs and types is presented in Table 2.

Table 2. The designs and types of research of the reviewed articles

Designs	Types	Articles (n)
Quantitative	Experiment	111
	Correlational	9
	Ex-post facto	7
	Causal-comparative	4
	Parallel multiple mediators	1
	Item analysis	7
	Cross-sectional survey	32
	Descriptive	25
	Sub-total	***196***
Qualitative	A-B (Baseline intervention)	2
	ATD (Anthropological theory of the didactic)	1
	DDR (Didactical design research)	2
	Interpretive	3
	DBR (Design-based research)	30
	Professional development	3
	Internet-based research	1
	Ethnography	12
	Descriptive	136
	Explorative	28
	Grounded theory	3
	Phenomenology	6
	Historical	1
	Case study	20

Designs	Types	Articles (n)
	Video analysis	1
	Sub-total	***249***
Mixed-methods	Convergent parallel	2
	Sequential	10
	Concurrent	9
	Sub-total	***21***
Research and development	TEQIP (Teacher quality improvement program)	1
	4D-Thiagarajan	22
	ASSURE model	1
	Identification, design, implement	1
	Puslitjaknov Kemdiknas model	1
	PPE (Planning, production, and evaluation) model	2
	RAD (Rapid application development) model	1
	ADDIE model	24
	Beyers (2011) model	1
	Tessmer (1993) model	20
	Budiyono (2017) model	2
	Plomp and Nieveen (2013)	15
	Borg and Gall (1983)	15
	Sub-total	***106***
Systematic literature review	Meta-analysis	5
	Extensive review	2
	Curriculum review	1
	Content analysis	5
	Sub-total	***13***
Classroom action research	CPAR (Critical participatory action research)	2
	Kemmis and McTaggart (2000)	8
	Sub-total	***10***
	Total	**595**

Distribution and the number of research participants

Most of the research participants were junior high school students (35,63%). Research involving the students are dominated by cognitive processes, development of PISA tasks, application of learning models, and mathematical abilities. The participation of university students or pre-service teachers (23,87%) began to be widely studied, especially relating to the application of technology, digital literacy, pedagogy, and university mathematics learning. Research on mathematics learning involving senior high school students (17,48%) has relatively the same topic as research that involves junior high school students, but it covers actual issues, such as metacognitive processes, defragmentation of thinking structures, arguments, and mathematical proofs. Studies on elementary school students (7,56%) received less attention, and the topics stick around media and teaching materials. Indonesian researchers, especially lecturers and undergraduates or graduates in the field of mathematics education in Indonesia, have not explored elementary mathematics due to the scientific nomenclature. Research at the elementary school level is mostly held by prospective teachers enrolled in elementary teacher education. At the early childhood level, there have not been any studies related to mathematics education. This

is different from the international community that places early childhood and elementary-level mathematics learning as one of the main topics. There is a small percentage (0,67%) of research involving students with special needs. Meanwhile, topics associated with teachers (7,23%) as research participants were about competence, belief, identity, and professional development. Community groups, professions, and literature studies (7,73%) have broader dimensions and are challenging topics. The distribution of research participants is shown in Figure 2.

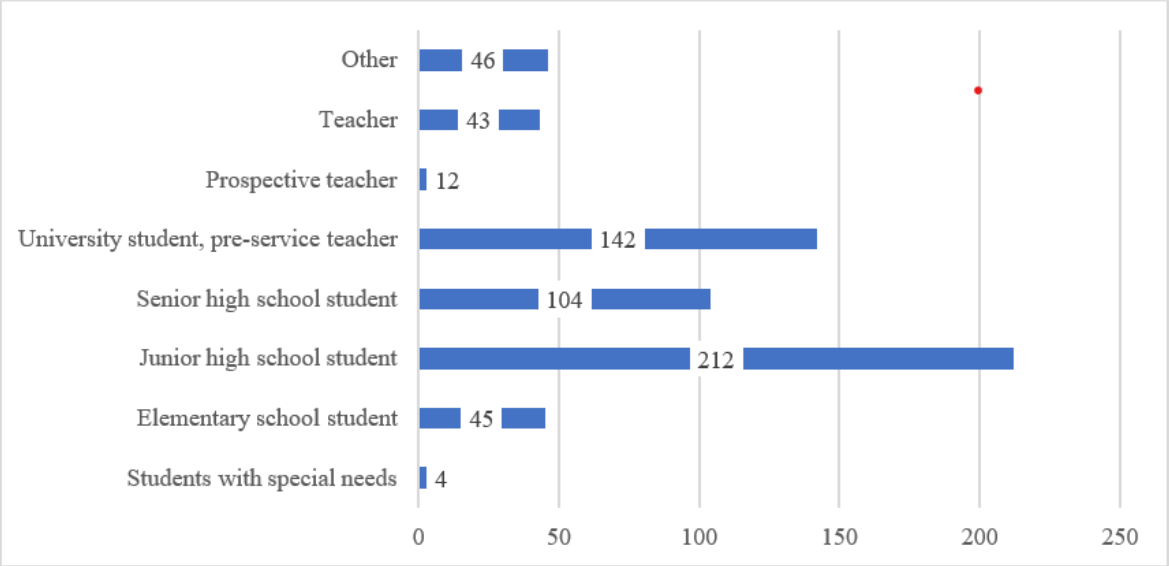

Figure 2. The distribution of research participants

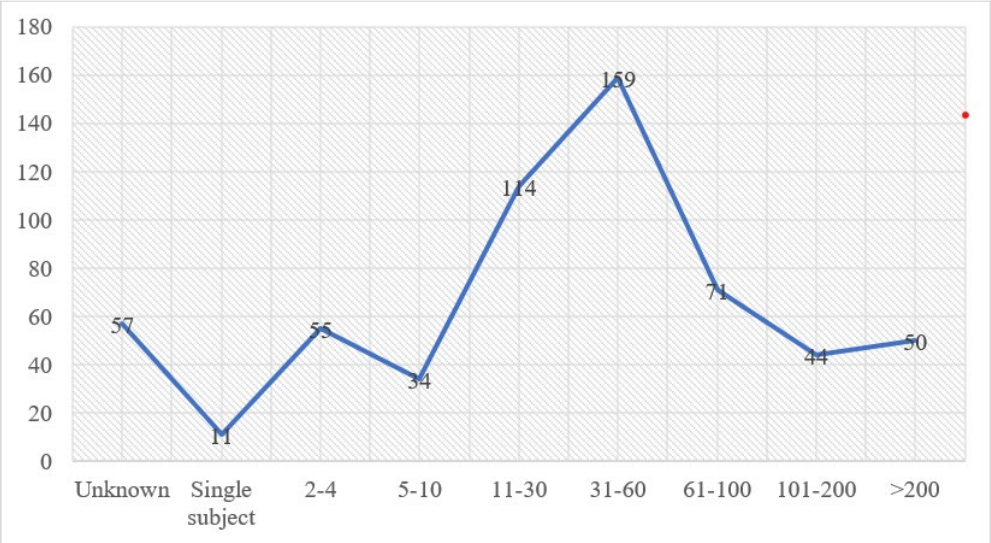

Figure 3. The number of research participants involved in the studies

The size of research sample 31-60 (26,72%) and 11-30 (19,16%) shows that the experimental research is still dominated by class as the sample. Qualitative studies with more than ten participants were also found in several studies. Qualitative studies with a sample size of 2-4 (9,24%) are still the majority with the division of criteria based on mathematical ability, or diagnostic test results. In addition, there is also a qualitative study with an ethnographic model involving between 5-10 (5,71%) participants. The development of instruments in a limited class,

especially referring to the Tessmer model, also involves a sample size of 5-10. Single-subject research (1,85%) began to be explored using a design-based research and type A-B (baseline intervention), although the number was not significant. Quantitative research with a survey model mostly used 61-100 (11,93%) samples. Furthermore, correlational analysis, path analysis, and SEM involving a sample size of more than 100 (15,8%) show an increasing trend in the last five years. Overall, the sample characteristics show that many quantitative studies have involved respondents with broader demographic characteristics. Meanwhile, research with an unknown sample size is dominated by literature review, curriculum review, and textbook analysis. The number of samples was not written explicitly in such studies.

Data collections

The dominance of qualitative studies resulted in the use of many interviews, documentation, and tests. Questionnaires are still the main choice in collecting quantitative data, followed by observation and tests. Meanwhile, expert validation (expert review) is widely used in development studies. The use of video recordings has begun to be widely used, especially in design-based research and experimental research. The use of e-learning platforms is also widely used in experimental classes as a result of learning during the Covid-19 pandemics. The PISA and TIMSS-like problems are widely used in various developments of HOTS-oriented assessment instruments. Activity-based tasks are also starting to be used, especially in qualitative studies. The analysis of the results of the national examination and teacher performance test was carried out in several literature studies. The use of field notes, focus group discussions, and reflective journals are mostly used in curriculum studies, classroom action research, and development studies. The summary of data collection in the reviewed articles is shown in Table 3.

Table 3. Data collection of the reviewed articles

Data collection	f
Interview	272
Questionnaire	195
Mathematical test	329
Observation	153
Document analysis, literature study, video recording	129
Expert review	80
Diagnostic test	46
Activity-based tasks	44
Mathematical Olympiad test	2
E-learning platforms	23
Rubric	24
Fieldnotes	21
Teaching materials	16
PISA/TIMSS standard test	12
Focus group discussion	6
Survey	5
National exam results	4
Teacher competency results	3
Reflective journal	4

Data analysis

Quantitative data analysis generally uses descriptive statistics and t-test. Experimental research with a factorial design mostly uses Anova and Manova, while Ancova and Mancova are rarely used. Data analysis to examine the relationship between variables is still dominated by correlation and regression tests. CFA, EFA, path analysis, and SEM are not widely used, indicating that correlational studies are more univariate. The non-parametric statistics frequently used are Mann Whitney, Wilcoxon, and Kruskal-Wallis. Research on instruments development utilizes expert reviews, walkthroughs, Aiken's V, Rasch models, and Cochran Q tests. Qualitative research is dominated by descriptive analysis referring to a specific model (Miles & Huberman, 1994) and error analysis techniques such as Watson (2007), Wallas (2018), and Newman (1983). In addition, there are also qualitative data using taxonomic analysis, think-aloud, and specific procedures for qualitative analysis. Furthermore, the use of qualitative software, such as Nvivo, and atlas-ti as analysis tools, has been used in several studies. In the systematic review of literature, many researchers use inductive analysis, content analysis, and meta-analysis. The summary of data analysis used in the reviewed articles is shown in Table 4.

Table 4. Data analysis used in the reviewed articles

Data analysis	f	Data analysis	f
Descriptive statistics	235	Bogdan and Biklen (2007)	3
Descriptive qualitative	183	Aiken's V	2
t-test	91	Graph representation	2
Expert review, walkthrough	66	AHM/CDM	2
Miles and Huberman (1994)	57	Comprehensive meta-analysis	2
Anova	49	Kruskal Wallis	2
Category analysis, taxonomy model	32	Q Cochran-test	2
Correlation	20	z-test	1
Regression	14	Binomial test	1
n-gain	14	Scheffe test	1
Manova	13	Contingency coefficient	1
Mann Whitney	13	Hierarchy linear model	1
Content analysis, inductive method	12	MDS	1
Creswell (2014)	9	RMSE	1
Think aloud	8	R-AMSTAR	1
CFA	7	Mean logit measure	1
Rasch	5	Self-explanation	1
EFA	5	FRISCO	1
Qualitative software (Nvivo, atlas ti)	4	Cooney et al. (1975)	1
Path analysis	4	Strauss and Corbin's grounded theory	1
SEM	4	Wallas (2018)	1
NEA	4	Braun and Clarke (2006)	1
Watson (2007)	4	Rogers (2003)	1
Ancova	4	Constant comparative method	1
Flow and constant comparison	3	RBC	1
Msi	3	Instrumental orchestra	1
Wilcoxon	3	Multilevel model	1

Frequently used keywords

The most frequent keywords used are mathematics or the characteristics that represent mathematics such as thinking, problem-solving, skills, creativity, cognitive, critical, analysis, understanding, and reasoning. Specific terms in mathematics learning such as geometry, word problem, spatial, teaching materials, STEM, PISA, RME, and ethnomathematics are also widely used. Covid-19, ICT, learning media, and games are keywords that represent the topic of online learning research during the pandemic. The keywords are highlighted in Table 5.

Table 5. List of frequently used keywords

Keyword	f	Keyword	f
Mathematics	173	Realistic Mathematics Education	17
Mathematical	125	Gender	16
Thinking	84	Ethnomathematics	16
Ability	61	GeoGebra	15
Teacher	57	Culture	13
Problem-solving	54	Contextual	13
Skill	39	Game	12
Understanding	37	Learning media	11
Reasoning	31	HOTS	11
Geometry	30	Collaborative	10
Development	28	Word problem	9
Creative	26	Covid-19	8
Analysis	23	Teaching materials	8
PISA	22	ICT	8
Critical	21	Motivation	8
Knowledge	21	Beliefs	8
STEM	18	Spatial	7

Study topics

The topics of the studies were dominated by mathematical ability followed by the application of learning models. Problem solving, literacy, and mathematical understanding are widely used as independent variables. Teaching materials development in digital forms have become an actual issue along with the use of digital technology. Applications of mathematical tools such as GeoGebra, MATLAB, Wolfram Mathematica, and scientific calculators are also used to support learning. Ethnomathematics as a study that connects mathematics and cultural activities of society has gained much attention. The use of robotics augmented reality, and e-games in mathematics learning has potential prospects for development. Student's thinking is still a potential issue with growing research. Furthermore, error analysis, misconceptions, and defragmentation become current issues in understanding the student's thinking. RME has much to do with the development of teaching materials, instruments, mathematical abilities, and didactic processes. Research related to the mathematics curriculum, learning trajectories, mathematics for children with special needs, emotional intelligence, and mathematics in the context of social justice is under-researched. The process of learning mathematics during the pandemic gave rise to several research topics related to flipped learning, remote learning, virtual learning, blended learning, and e-learning. The development of teacher professionalism refers to studies on TPACK, beliefs, identity, and teacher competence. The concept of STEM with

variations of its development has been widely studied, while the APOS theory has not been succinctly explored.

The study of Islamic values is a special topic in mathematics education research in Indonesia and has the potential to continue to grow. Differences in educational philosophy between the Western and Eastern world result in differences in studies involving religious values in mathematics education. The integration of religious values in education is 'unfamiliar' in the Western world because there is a separation between religion and some aspects of human life, including education. On the other hand, Indonesia, as a country that adheres to Eastern culture, places religion as a pillar of life, specifically education. This has led to many studies related to religious values in mathematics education research, especially Islam. In addition, Indonesia is a religious country with the largest Muslim population in the world. Islamic values and characters can be found in various manuscripts, artifacts, and there is even the oldest education system in Indonesia, namely Islamic boarding school (*pesantren*). The integration of religious values other than Islam has the potential to be explored, but this study has not received much attention. The highlight of the study topics is shown in Table 6.

Table 6. Study topics and sub-topics of the reviewed articles

Topics	Total	Sub-topics	Topics	Total	Sub-topics
Cognitive process	59	Cognitive style	Didactic	21	Design didactic
		Metacognitive			Research design
		Cognitive process			Learning trajectory
		Error analysis			Didactic obstacle
		Misconception	Learning model	48	Cooperative learning
		Cognitive structure			Collaborative learning
		Cognitive load theory			Problem-based learning
Mathematical ability	162	Reasoning			Project-based learning
		Communication			Direct learning
		Disposition	Mathematical curriculum	42	Framework design
		Connection			Textbook
		Representation			Curriculum comparison
		Argumentation			Teaching materials
		Proof	Psychology of mathematics education	21	Parenting
		Spatial			Math engagement
		Literacy			Socio-math
		Problem-solving			Socio-economic
Technology application	79	Software usage (GeoGebra, MATLAB, Calculator, adobe flash)			Socio-semiotics
		Augmented reality			Emotional quotient
		Game, comic, e-module			Mathematics anxiety
		ICT	Teacher education and professionalism	39	TPACK
		Multimedia (interactive videos, android)			Identity and beliefs

Topics	Total	Sub-topics	Topics	Total	Sub-topics
		Robotics			Tracer study
		STEM			Competencies
Ethnomathematics	27	Mathematics and culture	Realistic mathematics education	25	Teaching experiment
		Local wisdom			Task design
		Ethno-math learning			Local instruction
Instrument evaluation and development	52	Assessment instrument			Lesson study
		National exam	Other	33	Mathematics and Islamic value
		HOTS			Mathematical imagery
		PISA task			Mathematical value
		Word problem			Mathematical abstraction
Online learning	22	Flipped learning			Social justice
		e-learning			Solo taxonomy
		Mobile learning			Journal writing
		Virtual learning			Mathematics for special needs
		Blended learning			Bloom taxonomy
		Web-based learning			Math Olympiad

Cognitive process is a significant part of learning mathematics and have been comprehensively studied, such as cognitive processes in solving routine problems (Mairing, 2020), cognitive processes and mathematical conjecture (Astawa, 2020), and cognitive development processes (Widodo et al., 2020). Some of them are related to the defragmentation of thinking structures as a method for mathematical modeling (Wibawa et al., 2020). Research on cognitive style and its relationship to mathematical ability is still a crowded discussion topic (Hobri et al., 2020). Topics about the structure of students' thinking by considering scaffolding and pseudo-thinking have also been highlighted (Kusmaryono et al., 2020). Metacognition as a thinking process has been studied from various perspectives, such as cognitive abilities and self-regulation (Suryaningtyas & Setyaningrum, 2020), metacognitive ability level (Zakiah, 2020), and the relationship between metacognitive, gender, adversity quotient (MZ et al., 2017). Misconceptions and error analysis are topics of study related to cognitive processes that are often discussed (Agustiani, 2021). Furthermore, cognitive load theory has been studied in various perspectives, including mathematical literacy skills (Purnama & Retnowati, 2020) and worked examples (Irwansyah & Retnowati, 2019).

Mathematical ability is the most popular topic in the studies due to its association with other topics. Various mathematical abilities that have been researched are, for example, the relationship between mathematical reasoning, belief, and self-efficacy (Mukuka et al., 2021), mathematical communication and thinking sequences (Utami et al., 2020), mathematical communication and self-confidence (Murtafiah et al., 2021), mathematical disposition, reasoning, and representation, mathematical connection in problem-solving (Pambudi et al., 2020), and mathematical representation. The ability to prove is a topic that began to gain attention, for example, mathematical proof using APOS theory (Syamsuri et al., 2017), mathematical proof of geometry (Noto et al., 2019), and matrix (Ndemo, 2019). Furthermore,

the spatial ability has been associated with various issues, such as different cultural contexts (Indriani et al., 2020), online learning (Fitriyani et al., 2021), and gender (Nuriswaty et al., 2020). Problem-solving is still an appealing topic, including problem-solving heuristic models (Kusdinar et al., 2017) and problem-solving in conservation areas (Ekawati et al., 2019).

The advance of digital technology has contributed to the study topic of mathematics education. Software integration in mathematics learning is the most researched topic, especially the application of GeoGebra. Research on interactive video-based multimedia (Anwar et al., 2020) and bilingual multimedia (Rahim et al., 2020) has been done. The rapid development of technology does not only affects students in big cities but also affects students in remote areas (Pradipta et al., 2021). Mathematics learning using the latest technology, such as augmented reality and mobile learning (Cahyono et al., 2020), and robotics (Chahine et al., 2020), exists even though it is still very rare. The use of games has not escaped the spotlight of mathematics education researchers, involving game-based learning (Wijaya et al., 2021), animation (Safitri et al., 2020), and puzzles (Supriadi et al., 2020). Furthermore, research on the application of technology in mathematics curricula, such as STEM has been investigated for various possibilities in the classroom (Lasa et al., 2020). The technology application during the pandemic has made online learning the main choice so that research focuses on e-learning platforms (Farman & Chairuddin, 2020), flipped classrooms, blended learning (Wahyudi et al., 2019), mobile learning, web-based learning (Susanti et al., 2020), and virtual learning (Jatisunda et al., 2020)

Cultural factors have essential impacts on the success of learning mathematics. Culture-based mathematical research can be found in traditional house studies (Sulaiman & Nasir, 2020), season systems (Prahmana et al., 2021), traditional community rituals (Nur et al., 2021), and traditional games (Suddin & Deda, 2020). Furthermore, various forms of local content in mathematics learning show cultural significance (Putra & Baba, 2018). Culture-based learning can also be seen from the application of ethnomathematics-based visual basic and contextual learning with ethnomathematics (Nur et al., 2020).

The measurement and assessment of learning outcomes have received large attention in mathematics education research. The development of evaluation instruments in the form of PISA-based tasks is the most popular (e.g., Putri & Zulkardi, 2020). In addition, HOTS-based evaluation has also been developed, for example, a study from Harnita et al. (2021), evaluation instrument development using the RASCH model (Faradillah & Febriani, 2021), and item response theory (Santoso et al., 2019) has also been done. Furthermore, assessment during the pandemic also become the topic of study (Prabowo & Dahlan, 2020).

Students' difficulties in learning mathematics are also extensively studied from a didactic perspective. Instead of focusing on the mistakes made by students, researchers are more challenged to see students' thoughts in carrying out a series of activities and their learning barriers. Several didactic studies cover the topics of epistemological barriers (Tamba & Saragih, 2020) and anthropological didactic (Putra & Winsløw, 2019). Learning trajectories become more specific topics in didactic studies to determine the process of forming students learning experiences.

Although research related to the application of learning models is classified as classic, many researchers are still interested in using it as a topic of study. The cooperative learning model is a topic of research that is widely carried out involving various types of cooperative learning, such as TTW (Think Talk Write) or Jigsaw. Furthermore, the researchers use a project-based learning model integrated with ICT (Nurmi et al., 2020) and lesson study (Rahayu et al., 2021).

RME approach as a framework has inspired many researchers in Indonesia. Various studies relate it to collaborative learning (Sari & Putri, 2020), environment-based learning (Fauziah et al., 2020), and the education of children with special needs (Putranto & Marsigit, 2018).

Mathematics curriculum development is a topic that has potential in the future. This is because it has not been explored adequately while ideas can arise from any perspectives. Several mathematics curriculum designs have been produced, such as ELPSA (Febrilia & Patahuddin, 2019), web-based CRMS (Muttaqin et al., 2020), and RECCE-MODEL (Chong et al., 2019). In addition, a comparison of the mathematics curriculum both theoretically and empirically has been carried out, such as the comparison of the RME curriculum in the Netherlands and Indonesia (Revina & Leung, 2018), textbook comparison, and teaching materials comparison (Juniati & Budayasa, 2017).

The topic of the psychology of mathematics education includes in a general study. Some researchers use a broader paradigm to understand students' thinking processes. Study topics such as parental involvement and care (Fane & Sugito, 2019), socio-mathematics (Widodo et al., 2020), socio-economics (Kusaeri et al., 2018), and socio-semiotics (Daher & Thabet, 2020) are some factors that support the success of learning mathematics. Emotional and social intelligence are also an important spotlight in understanding students' thinking processes (Otgonbaatar, 2021). In addition, anxiety in learning mathematics is also a factor that can affect student learning.

Teacher education and professional development are important components that cannot be separated from the chain of improving the quality of mathematics learning. Related studies under the topics are pedagogical content knowledge (Subanji, 2015), teacher's pedagogy and beliefs (Muhtarom, 2020), and professional development and transformative learning (Bonghanoy et al., 2019). Furthermore, Islamic values in relation to mathematics education is of great interest to researchers in Indonesia. Some of them are Islamic context learning (Ulpah & Novikasari, 2020), Islamic values-based worksheets, and integration of the Qur'an in trigonometry (Ahmad et al., 2020). There are not many topics related to mathematics for children with special needs, so they have the potential to develop. Some examples of the related research include number puzzles for children with special needs, and autistic students and teacher behavior (Sabaruddin et al., 2020). Philosophical topics have received less attention from researchers in Indonesia, including; mathematical imagery, and the beauty and value of mathematics. Likewise, issues related to equity or social justice in mathematics education have not been widely discussed.

Conclusion and limitations

The reviewed articles reveal that: Firstly, qualitative research is the most popular research used in mathematics education research in Indonesia followed by quantitative research and development research. Secondly, junior high school students are mostly involved in mathematics education research in Indonesia. The majority of the studies has samples in the range of 30-60 participants. Thirdly, tests, interviews, and questionnaires are the dominant way of collecting research data used by mathematics education researchers in Indonesia, while the most popular data analysis is using descriptive statistics and descriptive qualitative. Fourthly, topics mostly studied are mathematical ability, application of technology, cognitive processes, and instrument development.

Research topics that have received less attention from Indonesian researchers are the teaching and learning of mathematics in early childhood and students with special needs,

philosophical and historical aspects of mathematics education, and the topics of multilingual, multicultural, and equity in mathematics education. A possible reason why research on the early childhood level and students with special needs has not developed is due to less collaboration between researchers in the field of mathematics education and in the field of early childhood or the field of non-formal education. The philosophy and history of mathematics education are still new issues for researchers in Indonesia. Multilingual and multicultural research is an important issue in mathematics education, especially in the context of Indonesia as the most diverse country in the world. However, multilingual and multicultural issues have not reached the transcendent side of education, such as curriculum development, frameworks, or learning models. Most of the multilingual and multicultural issues only touch the exotic side of various ethnomathematics studies. The issue of equity in various studies in Indonesia involves gender issues, but the related studies are still in the realm of cognitive and mathematical abilities. Equity issues that are more political and progressive or outside of mathematics education field have not been discussed, such as the problem of opportunity to obtain education in indigenous communities, stigmatization of women, and accessibility of education for children with special needs.

The limitations of this study can be distinguished in two aspects. Firstly, the data source is only from Sinta database. The results of research on mathematics education in Indonesia published in international databases are not included in the analysis process; thus, allowing for missing pieces of important information, especially regarding methodological trends and study topics. The research published in proceedings and book chapters were also excluded. Secondly, the publication is limited to the last seven years. This is to ensure the quality of the articles due to the refereed process. However, articles with good quality before that period were not accommodated in this study. Therefore, other researchers can consider the limitations of this study as a comparison or point of departure for future studies.

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