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A Systematic Literature Review: Development of Mathematics Learning Tools for Adolescents and Adults

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Abstract: ***Indonesian students are still weak in reasoning and problem solving, are only able to understand concepts, and are not familiar with questions that require logical thinking or the application of solutions. To improve mathematical literacy skills, innovation is needed through the development of learning tools. The purpose of this study is to review previous articles that have been published on the development of learning tools for mathematical literacy skills in high school students to university students in Indonesia using PRISMA. Search articles through the ProQuest database using the Boolean operators (AND) system. The research inclusion criteria are the publication of Research and Development designs and quantitative research with a publication year limitation of 2017 to 2022, research participants are high school students and college students. The results of the study obtained 16 articles that matched the eligibility criteria and were analyzed so that it was known that the learning tools both questions, question sheets, and models/approaches developed to support adult mathematics learning that were realized in Indonesia had been declared valid by experts so that they could proceed to the next stage.***

Keywords: mathematical learning model, mathematical literacy, systematic literature review

1. Introduction

Mathematics can be viewed as a system that includes ideas, principles, and processes so that the relationship must focus on aspects of reason or intelligence. Learning mathematics depends on one's cognitive structure so that mathematical knowledge between individuals will not be the same (Umbara & Suryadi, 2019). The cognitive process is defined as the process of thinking or management in processing the information received to be able to understand how the mechanism of something can happen and consider it. Cognitive processes in mathematical thinking consist of specifying, guessing, generalizing, and convincing which process can be improved through the development of mathematical literacy which conceptually refers to mathematical cognitive competence (Nisa et al., 2022).

Mathematical literacy is an important part of mathematics education and is categorized as good if it can analyze, reason, and communicate mathematical knowledge and skills effectively while being able to solve problems and interpret mathematical solutions (Maslihah et al., 2020). Mathematical literacy is described as an individual's ability to formulate, use, and interpret mathematics in various problem contexts, especially in guiding students to recognize the contribution of mathematics in life, including in making good decisions and providing judgments for people who are constructive and reflective. An individual is considered to have good mathematical literacy skills, then the individual is also considered to be able to think logically and critically and has a sensitivity to mathematical concepts that are appropriate to the problem (Maryani & Widjajanti, 2020).

The mathematical literacy ability of someone who can perform cognitive skills is certainly far above other individuals who are only able to interpret, analyze and evaluate so that it is known that each individual has a different level of mathematical literacy ability and can be viewed as a continuum level (Chasanah et al., 2020). All activities related to mathematical literacy involve higher-order thinking skills, where students must be able to formulate real problems into mathematical problems, have the necessary critical, logical, and metacognitive thinking skills (Maslihah et al., 2020).

Program for International Students Assessment (PISA) periodically assesses student performance in mathematical literacy and reports it to participate countries including Indonesia. However, the PISA assessment in 2018 showed that Indonesia had a low percentage and was ranked 73 out of 79 countries in detail the report stated that only 28% of Indonesian students succeeded in solving problems at level 2, namely being able to interpret and recognize situations in mathematical representations (Istiandaru et al., 2021). The results of Ehmke et al research also mention that adults' mathematical literacy skills are at the high school level (Holenstein et al., 2021), relevant to this argument, based on the Program for the International Assessment of Adult Competencies (PIAAC) performance report shows 7.5% of the adult population in 39 countries have a mathematical literacy level with a low classification or below level 1 (Gal et al., 2020).

Different studies also reveal that Indonesian students are still weak in reasoning and problem solving because they are only able to understand concepts and are not familiar with questions that require logical thinking or the application of solutions (Yulia et al., 2021). Another study also stated that the low value of Indonesian students' mathematical literacy skills was caused by students being less trained in solving problems that have contextual substance, demanding reasoning, argumentation, and creativity in solving them (Ghofur et al., 2022). Based on this, it is known that various

factors contribute to influencing mathematical literacy, for example, the characteristics of the school level, and teacher behavior during the implementation of learning in the classroom, while when viewed from the student's perspective, it is known that the factors that are considered to play a role include students' interests and self-concepts, grade level, gender, time allocated for learning mathematics, learning facilities at home, as well as an economic, social, and cultural status (Jailani et al., 2020).

The Ministry of Education and Culture considers that numeracy literacy indicators have a close relationship with reading activities; this is supported by other studies that state that there is a covariation between mathematical literacy and reading achievement so that it can improve skills in problem-solving, reasoning, and cognitive abilities (Holenstein et al., 2021). To support the development of numerical mathematical literacy, the Government of Indonesia has compiled a numeracy literacy book that discusses the scope of numeracy literacy material in the 2013 curriculum (Rakhmawati & Mustadi, 2022). To achieve the success of numerical mathematical literacy, a consistent strategy is needed to support the development of numerical literacy through the application of mathematical knowledge in other fields, in addition to using mathematics throughout the curriculum so that it can contribute to broadening and deepening understanding of numerical literacy as well as applying it in everyday life (T. M. Siregar et al., 2021).

One of the alternatives used in developing students' mathematical literacy skills, including the efforts made by teachers to support mathematical literacy, is by designing a teaching style that combines conventional knowledge and mathematical application activities so that it can support understanding of the subject matter (Bolstad, 2020). To improve literacy skills, it is necessary to use mathematics learning methods such as problem-based learning using a systemic approach so that students can gain important knowledge so that they are proficient in solving problems as well as being able to design strategies which are fundamental aspects of mathematical thinking (Widayati et al., 2020). The problem-based learning model is considered to support the characteristics of 21st-century learning that emphasizes students as the center of learning (Manggala & Yuniawatika, 2021).

The various learning models developed are considered effective in improving students' mathematical literacy skills when compared to learning models that use a teacher center or direct instruction approach. The learning models developed include problem-based learning models (Firdaus et al., 2017), problem-based learning model assisted by LMS (learning management system) using the Google site (Rahayu et al., 2021), a combination of realistic mathematics education and problem-solving processes that have been developed using the DAPIC principle (define, assess, plan, implement, communicate) (Sumirattana et al., 2017), realistic mathematics education based on Adobe Flash Professional CS6 with an emphasis on student self-learning (Umbara & Nuraeni, 2019), problem-solving with a CTL (contextual teaching and learning) approach (Afni & Hartono, 2020), TAPPS (think-aloud pair problem solving) model with a metaphorical thinking approach assisted by Class Dojo (Wardono et al., 2020), at the same time through collaborative inquiry (Malasari et al., 2020).

The improvement of mathematical literacy skills is also supported by the development of the learning media used. The media developed to consist of mathematics e-modules with STEM (science, technology, engineering, mathematics) collaborative project-based learning (Hadiyanti et al., 2021), e-book with ADDIE development method (analysis, design, development, implementation, evaluation), digital media such as VMK (Virtual Mathematics Kits) (Pradana et al., 2020), integrated ethnomathematics-based mobile learning (Julianto et al., 2021), e-learning with Schoology media (Wardono & Mariani, 2018).

The development of models and media as learning tools used is expected to contribute greatly to improving students' mathematical literacy skills. However, there is one factor that is considered to play an important role in influencing the low mathematical literacy skills of students, namely the learning that teachers apply tends to emphasize the final score rather than the achievement of mathematics learning materials, thereby making changes to student achievement goals. As the analysis in previous research states that mathematical literacy skills can increase if the goal orientation to be achieved has the characteristics of excellent mastery goals (Armitha et al., 2019). In line with this research, on the other hand, teachers are considered to have never analyzed mathematical errors from problem-solving made by students so that it results in the repetition of the same mistakes continuously (E. Siregar et al., 2021).

Based on the description above, it is necessary to carry out a systematic literature review regarding the models and learning media that have been developed and the challenges encountered to improve numerical mathematical literacy skills. This systematic literature review is very important to do as a basis for assessing the mathematical literacy skills of high school students and college students or analyzing which learning model is the most effective while exploring the gap between what is known and what is not known to improve mathematical literacy skills of students in Indonesia.

This systematic literature review uses the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) procedure which was developed by David Moher and his team in 2005. PRISMA consists of four steps, namely identification, screening, eligibility, and inclusion criteria. Identification is defined as the process of enriching keywords using several steps so that the articles obtained from the database can be retrieved as widely as possible. The second stage or screening stage is a process to include or exclude articles based on criteria determined by the author so that articles that do not match the type of article are deleted. The third stage is the feasibility stage where all articles are checked, starting from the title, abstract, methods, results, and discussion to ensure the article meets the inclusion criteria and is in line with the current research objectives. The last stage or the inclusion criteria stage is taking articles that meet the requirements for analysis. In this regard, it is necessary to analyze a broad scope based on the PRISMA

procedure to increase knowledge and understand its application (Mohamed et al., 2020).

The purpose of this study is to review previously published articles about models/approaches as learning tools that have been developed for mathematical literacy skills in high school students to university students in Indonesia using PRISMA on Scopus indexed articles in the ProQuest database, so that it can help educators in improving understanding, knowing the shortcomings as well as evaluating the learning methods used. To investigate the effect of model development and learning media on numerical mathematical literacy skills, there are several research questions, namely:

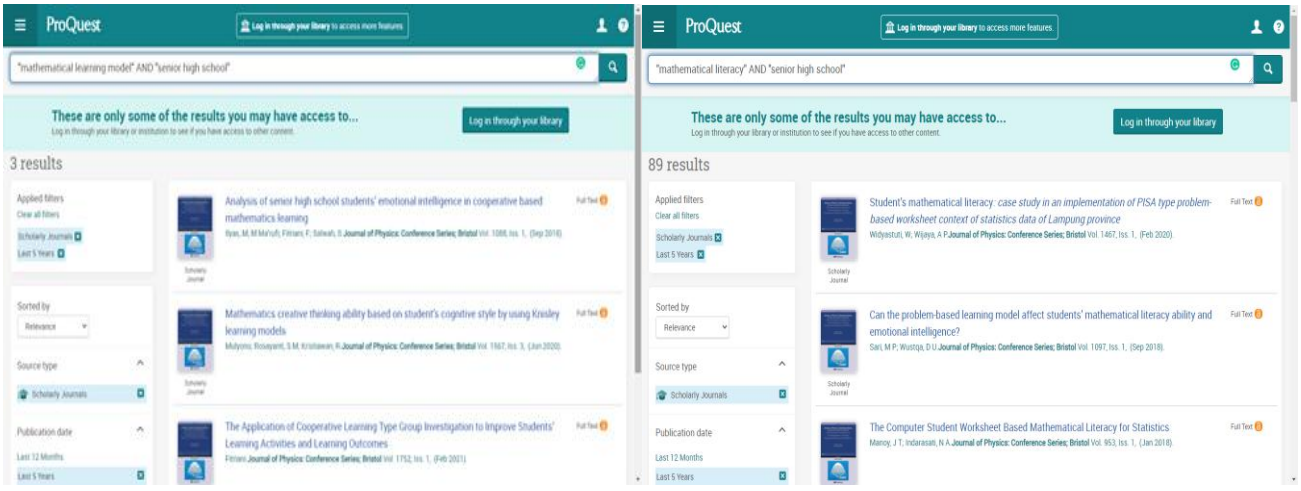
RQ1 : How are articles distributed over 5 years?
RQ2 : What is the distribution of participant level of the articles understudy?
RQ3 : How is the distribution of 'what', 'who', and 'how' related to the model or approach to learning mathematics towards literacy skills described in the article?

2. Method

A systematic literature review presents a collection of articles that are summarized and analyzed using objective, explicit and replicable techniques (Fung et al., 2021). The identification stage begins with a search process that combines keywords ("mathematical learning model", "mathematical literacy" and adds the subject "college student" or "senior high school") using the ProQuest database, and sets a limitation on the year of publication, namely the last 5 years with the 2017 to 2022 timeframe resulting in 463 articles (Figure 1). The screening stage, namely by reading the abstract of the article thoroughly to ensure the quality of the literature used, as for articles that are not related to learning mathematics or numerical literacy and articles that are not written in English, as well as articles that are not indexed by Scopus, are included in the exclusion category (Table 1) so that they are eliminated so that 359 articles did not meet the criteria, while 104 journals were obtained but 71 of them were excluded due to the unavailability of full text or open access articles. The third stage is eligibility, the author checks the feasibility of 33 articles starting from the title, abstract, method, to results and discussion to ensure compliance with the inclusion criteria but 17 articles were excluded because they did not meet the requirements, and at the included stage 16 articles were obtained to be reviewed in this study (Figure 2).

Table 1. The Included and excluded criteria

Criteria	Inclusion	Exclusion
Type of articles	Journal (research articles)	A review article, books, news-paper
Language	English	Not written in English
Timeline	Last 5 years (2017-2022)	≤ 2016
Field	Relevant to learning mathematics and numerical literacy	-
Countries	Indonesia	Other than Indonesia
Methods	Research and Development (R&D), quantitative	Qualitative, descriptive analysis



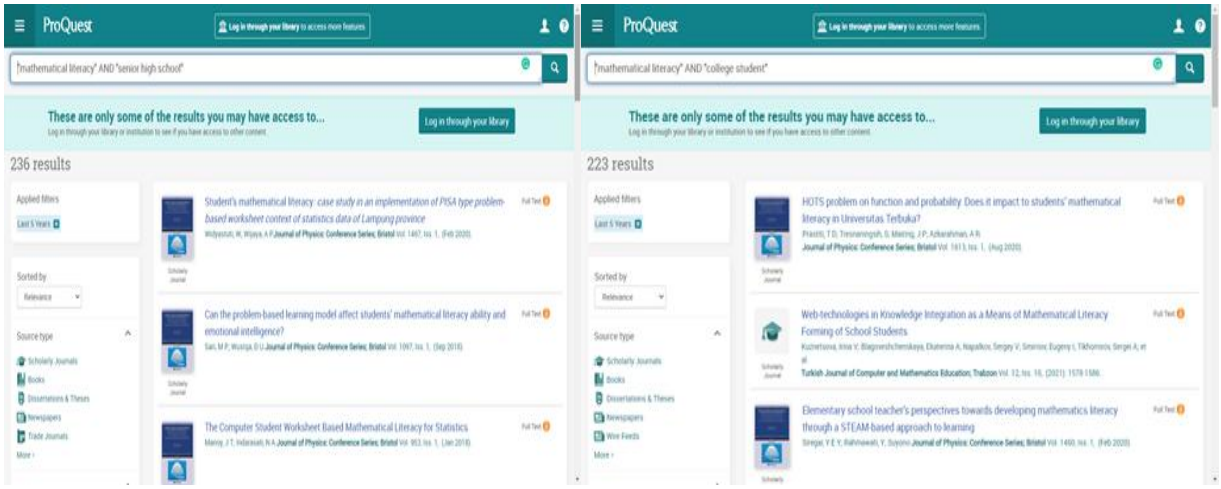


Figure 1: The procedure to include and exclude the access documents

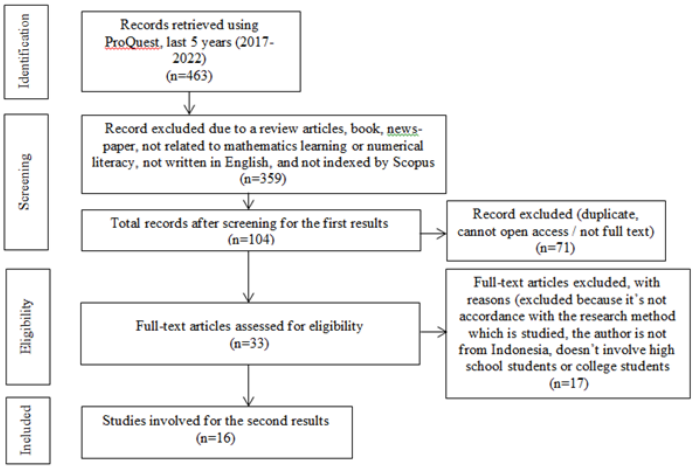


Figure 2. PRISMA's flow map

3. Findings and Discussion

3.1 Findings

Based on the search for articles according to the inclusion criteria and after the screening stage to the feasibility stage, it was found that 16 articles obtained from the ProQuest database came from the same 1 publisher, namely the Journal of Physics: Conference Series (indexed Scopus Q4) published by IOP Publishing from the United States Kingdoms. The articles studied were distributed by year and the level of education of the participants. Figures 3 and 4 show the distribution of articles by year of publication, so it is known that there were no published articles available in 2017 and 2022, but in the 2018-2021 period, 16 articles were found that discussed relevant themes to be studied with the majority focusing on high school students and college student. This shows that topics related to evaluating mathematics learning models and mathematical literacy skills in adults, both high school students and university students in Indonesia tend to experience a decline and lack of interest by researchers to evaluate further.

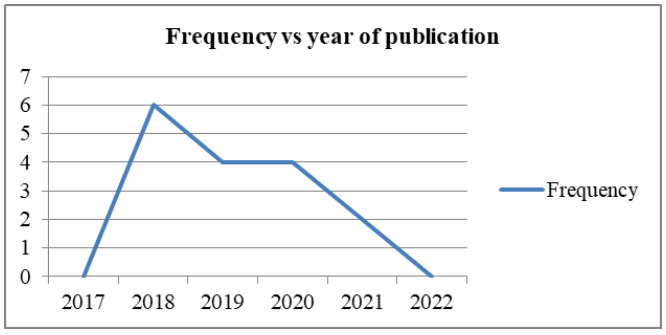


Figure 3. Trend and popularity of mathematical learning model and mathematical literacy

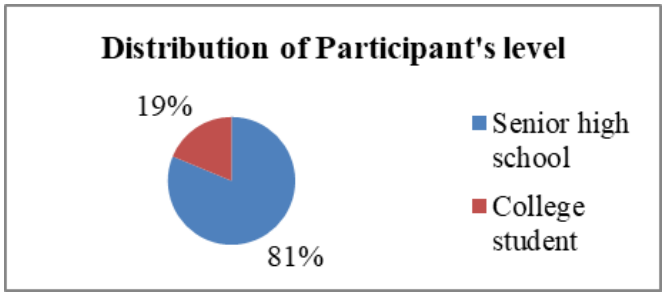


Figure 4. Distribution of literatures according to participant's level

Table 2. Distribution of 'what', 'who', and 'how'

Authors	What tools/approach?	Who involve?	What method to use?	How is the result?
(Manoy & Indarasati, 2018)	Development of worksheets based on computer mathematical literacy	Senior high school students	Thiagarajan (Four-D) development design	Valid, practical, effective
(Nizar et al., 2018)	Development of math problems based on the PISA model with the context of karate at the Asian Games	Senior high school students	Research and development	Valid and practical
(Yansen et al., 2018)	Development of math problems based on the PISA model with the context of 200 m swimming	Senior high school students	Research and development	Valid and practical
(Pratiwi et al., 2018)	Development of PISA model-based math problems with athletic context	Senior high school students	Research and development	Valid and practical
(Jannah et al., 2018)	Development of math problems based on the PISA model with the context of basketball	Senior high school students	Research and development	Valid and practical
(Utari & Zulkardi, 2019)	Development of PISA model-based math problems with coconut context	Senior high school students	Research and development	Valid and practical
(Sulistiani & Zulkardi, 2019)	Development of math problems based on the PISA model with the context of Indonesian food	Senior high school students	Research and development	Valid and practical
(Hardianti & Zulkardi, 2019)	Development of PISA model-based math problems in the context of Light Rail Transit (LRT)	Senior high school students	Research and development	Valid and practical
(Ayuningtyas et al., 2019)	Development of geometric reasoning ability test instrument	Senior high school students	Research and development	Valid and included in the good category in the aspect of instrument feasibility
(Faizasari et al., 2020)	Development of learning implementation plans and guided discovery-based question sheets adapted from the Plomp model	Senior high school students	Research and development	Valid and practical
(Fahmasari & Darmawijoyo, 2020)	Development of student worksheets	Senior high school students	Research and development	Valid and practical
(Susetyawati & Nuryani, 2021)	Development of HOTS-based math essay questions	Senior high school students	Research and development	Valid, reliable, and practical
(Kelana et al., 2020)	STEM (Science, Technology, Engineering, and Mathematics) approach	University students	Experiment	Effective
(Prastiti et al., 2020)	HOTS based student worksheet	University student	Experiment	Effective
(Ihsan & Zaki, 2018)	Performance-based mathematics learning model	University students	Combine of Research and Development (R&D) and experiment	Valid, reliable, and effective
(Mardiah et al., 2021)	Development of a teacher's book based on the Realistics Mathematics Education (RME) approach using the Plomp . model	Senior high school students	Research and Development	Valid

Table 2 describes the distribution of answers to the questions 'what', 'who', and 'how' related to the development of models or approaches to learning mathematics by involving high school students to university students. The first question refers to what models or approaches have been developed and applied by researchers in their research studies, for example through developing student questions and worksheets, developing reasoning ability test instruments, developing learning implementation plans, and developing learning models. Second, questions related to 'who' to find out the education level of participants, namely high school students and college students. The third question is related to 'how' the research method is carried out and 'how' the final result of the research so that it is known that the model and learning approach studied using the Research and Development method is declared valid, reliable, practical, and effective to be applied to support the benefits that are obtained by students during learning.

At the data search stage by emphasizing the keywords of the participants involved in the research, it was found that only 16 previous research articles were considered relevant to discuss the development of models and approaches to learning mathematics to support mathematical literacy skills

at an adult age, especially in high school to university level students, even though the percentage of people's literacy abilities adults are in a low category. When viewed based on the method used, the distribution of the article is divided into 13 studies that use development methods both in terms of questions (Hardianti & Zulkardi, 2019; Jannah et al., 2018; Nizar et al., 2018; Pratiwi et al., 2018; Sulistiani & Zulkardi, 2019; Susetyawati & Nuryani, 2021; Utari & Zulkardi, 2019; Yansen et al., 2018), student worksheets and learning tools/instruments (Ayuningtyas et al., 2019; Fahmasari & Darmawijoyo, 2020; Faizasari et al., 2020; Manoy & Indarasati, 2018), 2 studies using experimental research and have a control group as a comparison (Kelana et al., 2020; Prastiti et al., 2020), and 1 combination method between development and experiment which assesses the validation of the model and approach developed to the stage of evaluating the effectiveness to see the effect given to the group (Ihsan & Zaki, 2018). Based on this, it is known that the models and approaches that have been developed have been tested for validity first by experts and are declared valid so that they can be applied to adult learning systems, especially high school students to college students.

3.2 Discussion

One of the things that teachers as educators prepare is to develop learning tools by adjusting curriculum development, science, and technology, as well as adjusting to student characteristics. The implementation of learning must be arranged properly and correctly, and to achieve learning objectives, a teacher must utilize effective teaching materials including learning implementation plans and student worksheets and assessment sheets (Kurniasari & Kurniasari, 2020).

First, it is necessary to test the validity of the development of the learning device as a reference for assessing the feasibility of the extent to which the sample instrument is feasible to proceed to actual research. Validity is an important source of evidence and requires analysis in every process of its development adaptation which not only helps conceptually but also provides an explanation of the variance of the scores obtained (Delgado-Rico et al., 2012). One of the learning device development models used in Research and Development research is through the Plomp model which is known to be more flexible and flexible when compared to other development models because at each phase of its activities it can be adapted to the characteristics of the research being conducted (Faizasari et al., 2020; Mardiah et al., 2021). The article on the development of learning models/approaches that have been carried out in previous research states that these instruments are considered valid to be continued to the next stage or can be applied to students.

If it is reviewed based on its practicality and effectiveness, referring to the results of the study, it is known that the findings of previous research articles related to the development of learning models involving high school students and college students are still relatively few, even though the mathematical literacy abilities of adults still require monitoring. Previous studies stated that the biggest challenge faced by adults in doing learning is the challenges in themselves, time, finances, and families so further steps are needed to improve a conducive environment (Baharudin et al., 2013). Adult education is a key policy to achieve sustainable development goals. Things that need attention are adult learners have more time constraints and responsibilities, so learning is better life-oriented, structured, and flexible (Lu et al., 2022).

The teacher as a source of social support plays an important role in the development of students, including in developing students' literacy skills (Ma et al., 2021). However, there are dilemmas experienced by teachers when trying to apply constructive ideas in learning, especially when faced with challenges in encouraging students to develop ways of thinking while moving thinking towards scientifically acceptable ideas (Caspari-Gnann & Sevian, 2022). The development of mathematical problem solving requires teachers to be sensitive to the mathematical needs of students so that they are flexible enough to meet individual needs by asking questions that can stimulate the activation of students' thinking, verify solutions clearly, and be able to check the achievement of mathematical goals (Kaskens et al., 2020). Observations made in previous research showed that learning was still teacher-centered and sourced from school books without any other support such as student worksheets so students tended to not understand the concept of problem-solving (Yuwandra & Arnawa, 2020).

Various development models and approaches to learning mathematics for high school students and university students have been carried out by Indonesian researchers, both in terms of developing questions, developing student worksheets, and developing other tools that are considered valid, reliable, practical, and effective to be applied to students. First, through questions and student worksheets that previous studies have developed by applying a context-based approach and real-life connections (Ayuningtyas et al., 2019; Fahmasari & Darmawijoyo, 2020; Faizasari et al., 2020; Hardianti & Zulkardi, 2019; Jannah et al., 2018; Manoy & Indarasati, 2018; Nizar et al., 2018; Pratiwi et al., 2018; Sulistiani & Zulkardi, 2019; Susetyawati & Nuryani, 2021; Utari & Zulkardi, 2019; Yansen et al., 2018). In line with the article, there is supporting research that states that context-based mathematics education using story questions shows benefits as well as being a cheap learning medium, saving time, saving money, being flexible, and being easy to modify (Kuhn & Müller, 2014). The development of student worksheets was also carried out in other relevant research which concluded that student worksheets developed with the guided inquiry learning model were declared feasible to be used in the learning process to support the scientific attitude of high school students after being tested for validity by the assessment of academics and practitioners, judged practical based on calculations student response questionnaire, and assessed as effective which was measured referring to the analysis of student learning outcomes (Misbah et al., 2018). Relevant to this research, learning research based on worksheet development is considered perfect for increasing students' creativity and thinking skills (Krisdiana et al., 2019).

The development of questions and worksheets makes PISA a

reference. This is because PISA is considered to provide information that can assist policymakers in exploring interventions to support student achievement (Haw et al., 2021) through interventions that can hone higher order thinking skills (HOTS) (Prastiti et al., 2020; Susetyawati & Nuryani, 2021) because it involves mathematical thinking and reasoning, communication, critical attitude, interpretation, reflection, creativity, generalization, and mathematization. One of the mathematical abilities that underlie the mathematical process is modeling, but in Indonesia, mathematical modeling is not officially introduced at every school level and requires basic competencies to be able to develop it because mathematical modeling can equip students to improve mathematical literacy. Students with high modeling abilities can meet modeling indicators starting from the process of formulating, employing, and interpreting, while students with low modeling abilities tend not to be able to formulate or give appropriate conclusions on the questions presented and are only able to solve problems at a low level (Ambarita et al., 2018).

In addition, the use of digital tools and technology has a significant positive value in supporting learning (Hillmayr et al., 2020). One example of its application is by using the context of online mathematics learning as well as by applying digital games and utilizing technology (Kelana et al., 2020; Manoy & Indarasati, 2018). The analysis conducted in previous research states that the online learning approach based on social regulation is considered to be more able to improve student achievement and motivation to learn mathematics when compared to groups that are only given a conventional independent learning approach because students who apply the online learning approach tend to re-examine the additional material related the wrong questions were answered and wrote corrective notes as an evaluation, while the conventional group only paid attention to the test results and feedback provided by the teacher and at the same time rarely saw additional material or corrected notes. Thus, through the learning system developed, it is considered to be able to improve student learning performance while guiding student learning behavior to have more meaningful learning in mathematics (Hwang et al., 2021).

Other research applies a digital game-based learning approach at the elementary education level and based on qualitative data collected through classroom observations and interviews, the results showed that the scaffolding strategy applied affected student learning activities and mathematics perceptions (Sun et al., 2021). In line with the previous meta-analysis study which stated that digital-based interventions generally can improve math performance with an average Effect Size of 0.55 so that it can be used as the right instrument to help children with certain math needs as well as provide opportunities to carry out math tasks in solving math problems. alternative technology context (Benavides-Varela et al., 2020).

The various developments carried out are certainly carried out as an effort to facilitate and provide support in student learning activities. Students need support and assistance in interacting with learning materials to develop mathematical thinking habits to enable students to succeed in reading and learning mathematics. Support can be provided through adaptation of strategies including rereading, close reading, monitoring and asking, summarizing and paraphrasing, storytelling (story), evaluating and verifying, drawing, note-taking, and visualizing which is assessed to help students to understand complex problems (Fang & Chapman, 2020).

In connection with this, of course, teachers are required to be able to develop and use teaching materials that are by the needs and characteristics of students so that students are expected to be able to develop their mathematical abilities, including in terms of mathematical communication skills. The selection of the right teaching materials is one of the important factors that can determine the success of the learning process, while one of the teaching materials that can be developed is student worksheets that are packaged in such a way that students can study independently. The worksheet does not directly provide answers but presents practice questions in the form of essays that help students discover mathematical principles, as well as explore students' creative ideas in finding concepts (Sastri et al., 2018).

4. Conclusion

Teachers are required to be able to innovate and be creative in learning by developing learning tools that are oriented while facilitating the needs of students. Conventional methods that are generally applied in schools are still just lecture methods or accompanied by assignments that tend to be less interesting and make students easily bored so it becomes one of the factors causing low student learning outcomes. So the main thing needed in learning is a textbook. The development of textbooks and learning tools cannot be separated from the assessment of the validity (feasibility) test by several experts who are reviewed based on the feasibility of the material, the feasibility of the language, and the feasibility of the graphic. For the level of adult learning, starting from high school education to university level, it is known that there have been various developments carried out, both from developing questions, question sheets, learning approaches, as well as the tools used and have been declared valid to be applied to groups. The development carried out is intended as a form of facilitating students in increasing understanding related to the concept of the problem so that it can make it easier for students to understand the existing questions and the context presented.

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None

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