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Teachers' Roles in Designing and Implementing Numeracy-Oriented Instruction in Junior High School Mathematics: A Multiple Case Study

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ABSTRACT

This study investigates the role of mathematics teachers in junior high schools in promoting students' numeracy through the design and delivery of classroom instruction. The qualitative multiple-case study design was used to gather information on ten mathematics teachers, selected through purposive sampling based on teaching experience and willingness to participate, in the form of lesson plans, observations in classrooms, semi-structured interviews, and analysis of students' work, which were analyzed using a numeracy framework consisting of representation, conceptual understanding, procedural fluency, and reasoning, guiding thematic content analysis and cross-case comparison. The results show that educators have progressively incorporated real-life contexts and diagnostic tests in their instructional planning. Nevertheless, the combination of the various representations and the systematic development of mathematical reasoning is underdeveloped. These trends indicate that the primary problem with numeracy learning is not the accessibility of numeracy-related tasks, but rather the representation, reasoning, and coherence of instructional design. Based on this, the research indicates the need for professional development initiatives that specifically assist teachers in crafting exploratory, discourse-based numeracy assignments that are consonant with Minimum Competency Assessment (AKM) requirements and classroom contexts.

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1. INTRODUCTION

Numeracy literacy among junior high school students is a key area of learning mathematics, as it is a significant factor in the development of higher-order mathematical thinking. Numeracy literacy is an activity that entails the application of different kinds of numbers and symbols to address real-life problems, which helps students think systematically and critically in problem-solving and make reasonable decisions grounded in empirical information [1], [2], [3]. Numeracy is the skillfulness of a person to utilise the concepts of number and arithmetic operations to solve problems that are encountered in the life of a person, such as the capacity of a person to interpret quantitative information within the natural surroundings [4]. More simply, the term numeracy may be interpreted as the ability to reason and apply mathematical ideas in other contexts to address issues, along with the competence to explain how mathematics is applied to others [5].

Numeracy skills are not necessarily taught explicitly as a distinct mathematical discipline but rather taught contextually as part of other learning resources, even outside the field of mathematics, which is why they are also cross-disciplinary [6]. Practically, to measure literacy and numeracy skills, one has to provide information in various forms of representation, like a table, a graph, and a chart, which are in turn analysed and interpreted as grounds for decision-making and predicting phenomena.

Different attempts have been made to enhance the mathematical numeracy of junior high school students by implementing realistic mathematics education [7], problem-based learning supported by Quizizz [8], differentiated instruction as part of inquiry-based models [9], and creative problem-solving with the help of digital media [10]. Internal student factors have also been mentioned in several studies, including: personality type [11], learning styles [12], self-efficacy [13], multiple intelligences [14] and logical-mathematical intelligence [15]. Nevertheless, the low student numeracy remains affected by the low teacher competence and insufficient learning resources [16]. Moreover, most educators struggle with the development of numeracy items, leading to ineffective instructional planning [17]. Hidayah et al. [18] indicated that many teachers have difficulty creating numeracy items, which influences instructional planning. Their research on the nature of mathematics teachers' perceptions of the Indonesian National Curriculum highlights the challenges they face in integrating numeracy skills with the curriculum and other support programs. The above scenarios underscore the need for research that builds numeracy learning by enhancing the quality of teachers and, at the same time, the capabilities of students.

Numeracy literacy is a basic element of mathematics learning that enables students to interpret, apply, and communicate mathematical concepts in real-life situations. Within the Indonesian education system, numeracy has been a central competency as the Minimum Competency Assessment (AKM) and Merdeka Curriculum are used to institute it. These policy guidelines highlight the significance of mathematical thinking, contextual analysis, and the meaningful use of data in students' day-to-day lives. Merdeka Curriculum framework mentions Minimum Competency Assessment (AKM) as a learning assessment tool to investigate students' literacy and numeracy skills in a more authentic and contextualised way, by which learning will no longer focus on content mastery but rather on mathematical reasoning in real-life contexts. However, differences in teacher effectiveness in learning and applying numeracy concepts and difficulties in teaching numeracy literacy remain barriers identified in empirical research at the secondary school level. As demonstrated by Lestari et al. [19], although some mathematics teachers indicated they were prepared to teach literacy and numeracy as per the Merdeka Curriculum, almost half of the interviewed were unprepared due to a lack of experience and knowledge of effective numeracy teaching practices. The findings reveal that training, mentoring and professional development are necessary in order to make teachers design and carry out numeracy-based learning that is in tandem with AKM standards and the needs of students in the classroom.

Other past research has discussed the many instructional models and internal factors that impact numeracy development. Nevertheless, existing empirical studies on the integration of representation, reasoning, and assessment practices to develop numeracy-based lesson plans are scarce, especially in the framework of the AKM implementation in junior high schools. The gap shows that research is required to investigate how teachers play their roles not only as implementers of curriculum policy but also as curriculum designers and creators of learning environments that encourage mathematical thinking among students. Thus, there is still a research gap in understanding how numeracy learning could be structured in a way that leads to improved capabilities of students and the capacity of teachers to create items, choose approaches, and control the process of numeracy learning [20], [3].

Based on the above, this study will focus on whether junior high school mathematics teachers can encourage students to develop their numeracy skills through instructional design and delivery. Particularly, it answers the following questions: (1) How do teachers design lesson plans (RPP) oriented toward the development of students' mathematical numeracy? (2) What roles do teachers play in numeracy-oriented classroom activities? (3) What difficulties do teachers experience in developing numeracy items based on the Minimum Competency Assessment (AKM)? (4) How do teachers assess and reflect on students' numeracy development in mathematics classrooms?

2. METHOD

This study employed a qualitative multiple-case study design to obtain an in-depth understanding of teachers' roles in developing numeracy-oriented instruction. Ten junior high school mathematics teachers were selected through purposive sampling based on their teaching experience and willingness to participate. Data were collected through document analysis of lesson plans (RPP), classroom observations, and semi-structured interviews. Yin [21] claims that case study designs are especially appropriate for analysing complex, situational educational phenomena and for offering the opportunity to observe the perspectives of several participants in real-world contexts.

The sample was ten mathematics teachers working in junior high schools who were chosen with purposive sampling according to the following criteria: they actively taught in Grades VII, had at least three years of teaching experience and were willing to engage in all phases of the research. The teachers were analysed as unique cases, which provided the opportunity for cross-case analysis to determine patterns and differences, as well as unique findings across the teaching practices.

Data were collected through: (1) document analysis (lesson plans/RPP, numeracy items, teaching materials, and teacher reflections) to examine planning and implementation; (2) semi-structured interviews to explore teachers' perceptions, experiences, and strategies in fostering numeracy; (3) classroom observations guided by observation sheets to document instructional processes, interactions, and student responses; and (4) analysis of students' work as evidence of numeracy development. To analyse teachers' roles in designing

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numeracy-oriented instruction, this study employed a numeracy component framework comprising representation, concept, procedure, and mathematical reasoning. Indicators for each component are presented in Table 1.

Table 1. Numeracy Components and Indicators of Teachers' Roles in Instructional Design

Component	Aspect	Indicator
Representation	Teachers design learning activities that stimulate students to represent problem situations in mathematical models (graphs, tables, diagrams, mathematical expressions, symbols).	1. Teachers provide visual contexts (images, manipulatives, or simulations). 2. Instructional designs transform real-world situations into graphs, tables, diagrams, models, or mathematical symbols. 3. Instructional designs require students to explain relationships among representations.
Concept	Teachers design objectives and activities that help students develop meaningful conceptual understanding rather than merely memorising formulas.	1. Learning objectives emphasise meaning rather than results alone. 2. Teachers provide opportunities for exploration or concept discovery. 3. Teachers present examples and non-examples of mathematical concepts.
Procedure	Lesson plans include systematic step-by-step problem-solving procedures for applying algorithms or strategies accurately and efficiently.	1. Teachers guide students through problem-solving steps. 2. Students are given opportunities to apply procedures to real-world problem contexts. 3. Reflection activities address the efficiency of students' solution strategies.
Reasoning	Teachers design learning activities that promote logical thinking, justification, and conclusion drawing based on students' own reasoning.	1. Questions or tasks require students to explain their answers. 2. Teachers stimulate simple proofs or logical justifications. 3. Students are asked to identify patterns or make generalisations.

The indicators in Table 1 served as the basis for analysing and interpreting data from interviews, observations, and instructional documents. Data analysis followed content analysis procedures: (1) organizing all collected data; (2) coding data based on OECD and Indonesian Ministry of Education numeracy categories (representation, concept, procedure, reasoning); (3) identifying key themes related to teacher roles, challenges, and instructional strategies; and (4) drawing conclusions and verifying findings through source and method triangulation to enhance validity. Data analysis followed a thematic content analysis procedure, involving coding based on the numeracy components of representation, concept, procedure and reasoning. Peer debriefing was used to increase the credibility of the results, as the research team discussed the coding decisions, and selected interview passages were sent to participants to verify their interpretations. This was done to facilitate cross-case pattern consistency and to enhance the credibility in their interpretation.

Table 1, containing the indicators, served as the basis for the subsequent analysis and interpretation of data from interviews, classroom observations, and instructional documents regarding the role of teachers in developing numeracy. To derive tendencies in the research results based on the respondents' percentages, the percentage-based interpretation criteria were used, as demonstrated in Table 2.

Table 2. Percentage Interpretation Criteria for Research Findings

Percentage Range	Interpretation
100%	All research participants
76% - 99%	Nearly all research participants
51% - 75%	The majority of research participants
50%	Half of the research participants
26% - 49%	A small proportion of research participants
15% - 25%	A very small proportion of research participants
0%	None of the research participants

Sources: [22]

These percentage interpretation criteria were used to identify trends in the research findings based on the proportion of participants who demonstrated specific activities or roles. The research design is expected to yield relevant and applicable findings that improve students' mathematical numeracy by optimising mathematics teachers' roles at the junior high school level.

3. RESULTS AND DISCUSSION

3.1. Results

Cross-case analysis indicates that teachers' strengths lie in integrating real-world contexts and organising procedural steps in lesson planning. Most lesson plans include contextual tasks and diagnostic assessments to identify students' prior knowledge. However, only a small proportion of teachers consistently designed activities that required students to connect multiple representations or justify their reasoning.

Based on Figure 1, most teachers demonstrated an awareness of the importance of linking instruction to real-life contexts during the lesson planning stage. All participants (100%) reported actively seeking relevant real-world connections, such as buying and selling transactions and population data at the sub-district level. An excerpt from participant P7 illustrates this practice: "*I always start mathematics lessons with examples that are close to students' daily lives, such as the prices of food in the school canteen, so that students feel mathematics is part of their everyday life*." However, only a very small proportion of participants (2 out of 10, or 20%) formulated learning objectives collaboratively with students. Nearly all participants (8 out of 10, or 80%) formulated learning objectives based on existing textbooks or instructional modules. This practice is reflected in an interview excerpt from participant P3: "*I usually take the objectives directly from the module or the textbook. I rarely formulate them together with students because class time is limited and there is a lot of material to cover*." Nearly all participants (8 out of 10, or 80%) conducted diagnostic assessments as an initial step in designing lesson plans. Diagnostic assessment at the early planning stage serves as a foundation for formulating more targeted learning objectives.

Formulating learning objectives collaboratively with students.	P7	P9	P1	P2	P3	P4	P5	P6	P8	P10
Preparing instructional materials from multiple sources.	P7	P9	P1	P2	P3	P4	P5	P6	P8	P10
Identifying relevant real-life contexts.	P7	P9	P1	P2	P3	P4	P5	P6	P8	P10
Conducting diagnostic assessments.	P7	P9	P1	P2	P3	P4	P5	P6	P8	P10

Note: P as participants; implemented; Not implemented

Figure 1. Percentage of research participants' activities prior to designing the lesson plan (RPP)

Mathematics teachers design lesson plans (RPPs) with a focus on developing students' numeracy by integrating learning activities that encompass representation, conceptual understanding, procedural fluency, and mathematical reasoning. The results of the analysis of the lesson plans developed by the ten participants across the aspects of representation, concept, procedure, and mathematical reasoning are presented in Table 3.

Analysis of lesson plan (RPP) documents reveals that seven teachers (the majority, or 70%) have incorporated visual or symbolic representations, but have not consistently required students to connect across different forms of representation. For example, in T4's lesson plan, students were asked to solve problems based on a table of motor vehicle sales data, without any guidance to engage in mathematical modelling or to convert the data into graphs or other mathematical models. In contrast, a more comprehensive practice was found in P7's lesson plan, which included the following instruction: "*Students convert the table of library visitors into a line graph and then explain the relationship between changes in visitor numbers and the school activity schedule*."

Most of the lesson plans developed by the participants (80%) present clear and systematic procedural steps that are largely routine in nature. This observation means that teaching is still based on the idea of mastering algorithms and practising procedures, without balancing them with activities focused on reflecting on the efficiency or inner sense of the procedures applied. Consequently, students might be able to master calculations without knowing the reasons why certain procedures are used. In the reasoning, a majority of the lesson plans (80%) use either non-systematic or non-deep reasoning. This observation implies that teachers' ability to develop tasks that encourage students' mathematical reasoning is low. The learning activities normally end with the completion of the problems, without the need to request the students to have an explanation of their responses, generalising, and inference about the mathematical patterns.

Table 3. Results of the Analysis of Lesson Plans Developed by the Research Participants

Aspect	Results of Lesson Plans	Performance Participants
Teachers design learning activities that stimulate students to represent problem situations using mathematical models.	Various representations are used meaningfully and linked between forms.	P7 P9
	Representations are used but not yet connected between forms.	P1,P2, P3, P4, P5, P6 P8
	Representation appears in a limited form (only one form, e.g., table).	P10
	There are no representation activities in the lesson plans (RPP).	-
Teachers design learning objectives and activities that help students understand mathematical concepts in a meaningful way.	The lesson plans include exploratory activities and student discussions in help students understand mathematical concepts.	P7
	There are learning activities that focus on understanding concepts, but teacher explanations still dominate them.	P1, P2, P3, P4, P5, P6 P8, P9
	Understanding of concepts is only implied (through practice or formulas).	P10
	There is no indication of strengthening the concept.	-
The lesson plans prepared by teachers include step-by-step problem-solving strategies that are correct and efficient.	The lesson plan (RPP) presents clear, systematic procedures and provides space for reflection.	-
	Procedural steps are clear but routine.	P1, P2, P3, P4, P5, P6 P7, P9
	There are procedural exercises without instructions or reflection.	P8 P10
	There is no explicit mathematical procedure.	-
Teachers design mathematics learning activities that lead to logical thinking, justification, or drawing conclusions based on students' own thinking.	The lesson plan contains explicit argumentation and justification activities.	-
	There are elements of reasoning, but they are not yet systematic or in-depth.	P1, P2, P3, P4, P5, P6 P7, P9
	Reasoning appears only in the form of closed questions.	P8 P10
	There is no mathematical reasoning activity.	-

Overall, the analysis indicates that the four elements of numeracy are represented in teachers' lesson plans. However, they are mostly at the simplest procedural and conceptual levels, and the strongest element of numeracy is representation and reasoning, which are the weakest in this case. This tendency prioritises content coverage and algorithmic practice over developing deeper mathematical thinking, a major component of mathematical numeracy.

Observations in classrooms showed that mathematical discourse was frequent and mainly centred on closed-ended questions, often focusing on final answers rather than explanations or comparisons of strategies. Only a small number of situations were found where dialogic practices were more thorough, with teachers providing students with an opportunity to explain and discuss various solutions. Even though all teachers start lessons with the relevant real-world contexts, the mathematical discourse that results is usually unilinear. During the classroom observations, P2, e.g., the teacher asked questions like "*What is the result*?" and "*Which steps did you use*?" but did not follow up with questions that required students to justify their reasoning or compare alternative strategies. More dialogic practices were observed in only two classrooms, one of which was P7's. This teacher consistently responded to students' answers with probing questions, such as "*Why did you choose that method*?" and "*Is there another strategy that might be more efficient*?" This method prompted other learners to participate in assessing and explaining arguments, so the classroom conversation no longer focused on seeking answers but on exploring mathematical thinking.

The use of real-world contexts in instruction varied in depth. In P4's class, the context of "monthly household expenditures" was only an introductory prompt, and instruction was then transferred to the formal exercises of calculation. Conversely, during the lesson in P9, the teacher maintained the context throughout by instructing the students to reinterpret their calculations in decision-making terms, including defining the most efficient way to spend in a month. However, the justification and the consequences of mathematical findings were still the preserve of a few active students, while the majority played rather passive roles as consumers of information.

The weakest aspect of lesson plan analysis and classroom observation was reasoning. The majority of participants used closed-ended questions based on end-story answers, and students did not need to explain or make generalisations. In the P8 lesson plan, everything was in the form of multiple-choice or short-answer questions, and there was no prompt asking students to discuss their thinking. Classroom observations supported this trend: each time a student gave a different response, the teacher immediately corrected him/her and presented the solution at the board, thus preventing classroom discussion of the topic. This tendency means that the teaching process is not directed toward evaluation and mathematical justification but toward confirming the answers.

The results of interviews show that teachers have problems with implementing AKM numeracy, which are dependent on both pedagogical and structural limitations. The majority of participants (7 out of 10, or 70%) noted problems in creating an item that combines a real-life situation with the requirements of mathematical thinking. One participant stated: "*I can make ordinary word problems, but when they have to follow the AKM format that requires* *analysis and justification, that is the hardest part*." (P6). Nearly all participants (8 out of 10, or 80%) identified heavy teaching loads as a major barrier to in-depth planning and post-instructional reflection: "*If I want to make good numeracy questions, they have to be tried out and revised. But with my current teaching schedule, there is almost no time for that*." (P5). Furthermore, other teachers had problems in balancing numerical and textual requirements in test items, especially when students' reading literacy levels were lower. Consequently, instructors were more likely to make the textual elements of activities simple, thereby minimising the complexity of the situation and the richness of the reasoning that should have been presented.

3.2. Discussion

Students can be more engaged in the planning process for their instruction when mathematics teachers consider students' interests, needs, and cognitive development levels, as well as the design of instruction. This opinion is corroborated by Ampadu [23] and Goertzen [24], who argue that joint development of learning goals positively affects students' engagement and perceptions of the learning process. As students are engaged in establishing learning objectives and achievement standards, they will be more conscious of where they are headed, which will result in a sense of ownership and a self-critical evaluation of their learning progress. Thus, the learning of mathematics will be more meaningful and offer gradual cognitive challenges in the context of mathematical numeracy, encouraging active engagement and the development of mathematical dispositions. The idea of designing mathematics teaching by preparing materials from various sources and by recognising real-life situations is a significant factor in developing students' mathematical numeracy. This conclusion is in line with Weber, who demonstrated that involvement in context-based activities in real life, and markets in particular, can foster informal mathematical skills [25] as well as Sigus and Mädamürk [26] who indicated that preparing instructional material in multiple sources, along with the incorporation of students in recognising an everyday-life context, can not only improve content but also enhances the capacity of students to apply mathematics meaningfully. In this respect, mathematics education with a focus on real-life situations will assist students in learning the language and meaning of numerical data more effectively and in building a broader perspective on mathematical phenomena. Also, assignments may be constructed so that they help students develop their skills in defining problems mathematically, interpreting data, and presenting their responses in a logical and systematic form. This observation aligns with Fan, who highlights that diagnostic evaluation is a strategic aspect of lesson planning during the first phase, as it helps determine students' learning preparedness, comprehension deficiencies, and potential [27]. The outcomes of assessment, in turn, help the mathematics teachers group learners based on their needs, choose reading materials that convey the conceptual meaning of numeracy, and create assignments that combine reading literacy and numerical problem-solving tests.

The findings of the research studies show that the majority of the teachers understand the significance of visual representation in assisting students in understanding, even though they have yet to develop students' capacity to move across representations fully. This implies a need to enhance teachers' ability to develop activities that help students associate various forms of representation in solving problems more comprehensively. In the PISA Mathematics Framework [28], representational competence is one of the indicators of numeracy literacy because it facilitates the modelling and analysis of real-life scenarios in mathematical form. The lack of this aspect corresponds to the idea that teachers' lesson plans continue to view representations as instructional tools rather than as part of more complex processes of mathematical thought. At the conceptual level, the lesson plans developed by the participants focus on conceptual understanding, but they are still characterised by teacher explanation. These results indicate that although the majority of teachers intend to develop conceptual knowledge, their teaching methods are very teacher-oriented. The given condition can be compared with the findings of the Indonesian Ministry of Education, Kemendikbudristek [29], which state that a significant number of teachers are predisposed to focus on final results rather than the process of knowledge building among students. Nevertheless, assert that conceptual understanding is a non-preparatory part of mathematical proficiency that is attained to support the sustainable development of numeracy. This means that teacher-centred instruction should be shifted to student-centred instruction through exploratory, manipulative, and meaning-based discussions of mathematical concepts.

In the context of numeracy, meaningful procedural competence is not only the capacity to handle or execute algorithmic steps, but a sense of why such procedures should be used and the capability to make them apply flexibly in a variety of problem situations. According to Star [30, procedural knowledge has different levels of depth, i.e., mechanical knowledge, procedural knowledge coupled with flexibility, and strategic thinking. A curriculum that emphasises too many processes without reflection and sense-making might impede students' ability to resolve non-routine or contextual problems, which are the primary aspects of numeracy competence. Numeracy literacy includes reasoning, as it helps students make inferences and generalisations and link mathematical concepts logically [31]. The lack of argumentative tasks in the lesson plans indicates that the teaching process is still focused on final answers rather than on critical thinking and mathematical reasoning. Educators thus require instructions on how to construct open-ended questions and discussion activities that require pupils to explain why they gave the answers they did.

Mathematics teachers make a strategic contribution to numeracy instruction in the classroom, evident in planning, instruction, assessment, and reflection. It is at this stage of planning that the teachers develop lesson plans (RPPs) that focus on exploring numbers, symbols, and real-world contexts by combining the nature of AKM numeracy items. This type of goal- and context-based planning promotes student participation in higher-order thinking activities, especially in critical analysis and problem-solving. To assist in these purposes, educators also select appropriate learning materials and teaching methods by drawing on professional resources, including academic journals and web-based learning platforms, and by implementing differentiated instruction to meet the learning needs and characteristics of students with diverse features. Such a method provides students with valuable, pertinent learning assistance, helping them develop their numeracy potential to the best of their ability [32].

In implementation in the classroom, the role of teachers is to facilitate the mathematical discourse by engaging in instruction methods that encourage dialogue, sharing of ideas and development of a positive learning environment. The students have the opportunity to present, defend, and revise numerical arguments in a group through structured mathematical discussions. These discourse strategies have been demonstrated to enhance students' conceptual learning and develop mathematical reasoning in numeracy situations [33]. Moreover, teachers' self-efficacy in teaching mathematics determines the effectiveness of numeracy instruction. More teacher confidence is associated with a greater number of teachers using cognitive activators, giving explicit directions, and managing the classroom in the best way possible. It is an indirect mediator of the positive effects on students' numeracy achievement because they are exposed to learning environments that are more organised and intellectually demanding [34].

During the assessment and reflection phase, educators administer data-based formative assessment, such as tools to visualise students' numeracy skills, to track learning progress continuously. Teacher reflection is based on assessment results, and the adjustment of instructional strategy or intervention is based on the evaluation outcomes. This type of sustained assessment and reflection practice can play an important role in enhancing the quality of classroom-based numeracy teaching[35]. In general, the integration of goal-oriented instructional planning, support for mathematical dialogue, high levels of teacher self-efficacy, appropriate selection of resources and strategies, and the ongoing adoption of assessment and reflection make the mathematics teacher one of the critical contributors to the development of numeracy literacy in students.

Thus, in implementing AKM numeracy, mathematics teachers face a range of pedagogical and structural challenges. According to Suryani et al. [36], in many cases, teachers who are only starting their careers (less than 5 years of practice) have not yet had time to master the instructional and assessment strategies that align with the AKM numeracy standards. This scenario complicates the process by which teachers may have to alter content, approaches, and item types to the nature of numeracy assessments that require abstract knowledge, rationale, and the implementation of mathematics in real-life situations. Further, the absence of professional training dedicated to AKM literacy and numeracy is also another obstacle. The current professional development initiatives are also insufficient and are not yet the best means of equipping teachers with a profound understanding of the nature, construction principles, and indicators of AKM numeracy items. Consequently, educators tend to feel less confident and not sufficiently prepared to plan numeracy items that fully meet the AKM requirements.

The other significant limitation is the high working load. The heavy instructional requirements inhibit teachers from devoting enough time to designing, piloting, and revising numeracy items continuously. This circumstance influences the quality of the tasks created, which can be less varied, less context-specific, or not entirely representative of AKM numeracy needs 37]. In addition, restricted access to learning materials and technology is an inhibiting factor, especially in providing real-life scenarios using digital materials and supporting software and technology-based learning facilities.

One more difficulty is combining reading literacy and numeracy, as AKM evaluates both skills simultaneously. Educators often find it challenging to create exercises that include both numerical and textual values, particularly for learners with low reading literacy [38].

This task is also complicated by the lack of quick, comprehensive formative feedback, as it is hard for teachers to find diagnostic data to track their numeracy development in real time. As a result, it is not possible to conduct reflection and instructional improvement processes optimally and responsively. Altogether, the lack of teaching experience, low levels of professional training, special attention to numeracy, workloads, access to resources and technologies, and limited formative feedback can be viewed as the main combination of difficulties that elementary mathematics teachers encounter when designing and implementing AKM numeracy tasks in the classroom.

Teachers are generally aware of numeracy as a competency requirement in mathematics. Nonetheless, this perception has not been actualised in assessment and reflective practices in totality. Numeracy is impacted by the joint effect of language and mathematical skills [39]. Language competence helps students make sense of tasks, describe processes, and support their responses appropriately. The lack of linguistic fluency can lead students to be unable to express their ideas in language and to interpret numerical data in the form of text, graphs, tables, and mathematical symbols. Proved that the reflective thinking of prospective teachers during the process of solving numeracy literacy problems is based on the mathematical disposition, and the factual reflection is believed to be the guiding principle of the development of numeracy literacy. However, its application in classroom activities remains minimal [40].

According to the general findings and the discussion, it may be concluded that the emergence of numeracy in the teaching of mathematics in junior high schools is not predetermined solely by the abundance of contextual and procedural learning activities. However, it is also critically dependent on the quality of the activity design, its teaching implementation, as well as teachers' ability to perform ongoing assessment and reflection. Even though teachers recognise the significance of numeracy and AKM, classroom practices in the classrooms have yet to go the distance in facilitating deep cognitive learning among learners, especially in reasoning, reflection, and mathematical argumentation. This situation underscores the importance of enhancing teachers' pedagogical capabilities, geared towards active, reflective, and meaningful learning, as a core requirement for ensuring the sustainable growth of numeracy literacy in students.

Theoretically speaking, the results imply in disproportionate application of the numeracy elements, with procedural and conceptual elements prevailing over representation and reasoning. Under the OECD and PISA mathematics scheme, the two are representation and reasoning, which are at the heart of the formulation, use, and interpretation of mathematics in real-world contexts. Underemphasizing these elements would risk numeracy learning becoming procedural rather than reflective and meaningful. Practically, these patterns are indicators of instructional designs that facilitate transformation through cross-representation, open-ended questioning, and structured mathematical discourse. These strategies would help students develop more flexible problem-solving approaches and greater conceptual knowledge. The implications of the findings for policymakers are to focus on teacher training initiatives that emphasise the design of modelling-based numeracy tasks and the encouragement of mathematical discourse, rather than just the provision of AKM formats. In this light, the teaching of numeracy in the junior high school level may be redirected not necessarily toward procedural completion, but more toward the development of reasoning and mathematical decision-making, which are the pillars of numeracy literacy in 21st-century learning.

Based on the research results, junior high school mathematics teachers designed lesson plans that considered real-world contexts and step-by-step procedures, and most conducted diagnostic assessments to determine students' initial abilities, though only a small number planned learning objectives collaboratively. Analysis of lesson plans and classroom observations showed that most teachers developed representations and procedural fluency. However, conceptual understanding and mathematical reasoning remained limited, characterised by the dominance of teacher explanations and the use of closed questions, while open discussions and mathematical argumentation occurred in only a few teachers, such as P7. Teachers also faced difficulties in designing AKM-based numeracy problems due to integrating real-world contexts with analysis and justification, high teaching loads, limited access to learning resources and technology, and limited professional training specifically for AKM numeracy. Thus, although teachers have the potential to encourage numeracy development through planning, classroom facilitation, and assessment, current practices still emphasise procedural aspects and simple representations. At the same time, students' abilities in conceptual understanding and mathematical reasoning remain limited, so improving learning strategies that encourage reflection, argumentation, and connections among numeracy elements is urgently needed.

4. CONCLUSION

This study has shown that, although the use of numeracy-based practices within the mathematics classroom of junior high schools has seen an increasing involvement of real-world contexts and processes within the teaching and learning process, teachers’ practices are stronger in representation and procedural fluency. At the same time, conceptual understanding and mathematical reasoning remain limited.

The key contribution of the research is the discovery of a lack of balance in the application of the elements of numeracy, whereby instructional construction patterns are usually focused on procedural accomplishment rather than on advancing students' modelling, justification, and reflexive reasoning.

These results highlight the need to align teacher professional development with the objectives of the AKM and Merdeka Curricula, focusing on the design and implementation of exploratory, argument-based, and reflective numeracy tasks. Strengthening the role of teachers as creators and facilitators of meaningful mathematical experiences is crucial for fostering sustainable numeracy literacy and equipping students with the reasoning and decision-making skills required in 21st-century learning. Overall, these findings indicate that, while teachers incorporate real-world contexts and procedural steps, additional support is needed to ensure more balanced numeracy instruction, addressing current limitations in lesson planning, classroom practices, and assessment.

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