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Developing a workshop model for high school mathematics teachers constructing HOTS questions through the *Pendidikan Matematika Realistik Indonesia* approach

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Abstract

Indonesia's Program for International Student Assessment (PISA) results from 2000 to 2018 are worrisome because they are at the bottom of the international rankings. This result illustrates the low quality of education in Indonesia, which correlates with the qualifications of teachers. The quality of education will increase proportionally to the proportion of teachers who possess the necessary skills. Therefore, this study aims to train teachers to increase their professionalism in developing HOTs questions using the *Pendidikan Matematika Realistik Indonesia* (PMRI) approach. Design research-type development studies with two stages, preliminary and formative evaluation, are utilized. The results of the workshop revealed that the teacher's competency scores in developing HOTs questions increased by 45.70% (before the workshop), 77.14% (workshop 1), and 85.70% (workshop 2), respectively. This is evidenced by the teacher's ability to develop HOTs questions with the characteristics of questions investigating number content within the local context of selling Duku fruits, which is a typical fruit of the East Ogan Komering Ulu (OKU) Regency, and with a high degree of difficulty. This research also affects students in that it can stimulate their critical thinking abilities.

Keywords: Design Research, HOTS, *Pendidikan Matematika Realistik Indonesia*, PISA, Workshop

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The Indonesian government has and will continue to prioritize improving the country's educational system. The Indonesian government has adopted the Programme for International Student Assessment (PISA) as an international benchmark for the Indonesian education system (MoEC, 2019). PISA is a triennial assessment that evaluates students' proficiency in reading, mathematics, and science for 15-year-old students (OECD, 2018). Reflecting on the past two decades of PISA results are exceptionally alarming because they have remained stagnant (OECD, 2018, 2019a).

The low PISA score indicates that much work still needs to be completed. The lack of higher-order thinking skills necessitates the revision of the KTSP curriculum to the 2013 version (MoEC, 2019). The 2013 curriculum begins with the premise that previous learning processes cannot investigate students' abilities to give reasons with complete information, manage information, generalize, and solve nontrivial problems (Putri & Zulkardi, 2018). The implementation of the 2013 curriculum is the result of efforts to improve Indonesian students' mathematical literacy (Putri & Zulkardi, 2019). Furthermore, Nusantara et al. (2021) explain that students who learn mathematics via mathematical literacy questions are driven to practice higher-order thinking. The need to provide HOTs to students because improving quality in all parts of life is unavoidable (Azid et al., 2022). Lastly, Meryansumayeka et al. (2022) explore that HOTs are mathematical reasoning abilities that are also one of the areas of mathematics instruction in the school curriculum.

A realistic mathematics approach can help students think more critically at a higher level. Its curriculum centered on HOTs questions can enhance student learning outcomes and activities (Tanujaya et al., 2021; 2023). *Pendidikan Matematika Realistik Indonesia* (PMRI) or Realistic Mathematics Education (RME) is a mathematics learning theory that originated in the Netherlands and has been modified to the characteristics of the Indonesian context (Prahmana & Suwasti, 2014; Zulkardi et al., 2020). PMRI develops deep, long-term mathematical learning, beginning with contexts students can grasp (Van Galen & Van Eerde, 2018). PMRI is a way of teaching and learning mathematics that begins with "real" things to "abstract" so that students can find the math and then use it to solve their problems (Zulkardi & Putri, 2019; Fitri & Prahmana, 2020). Students can design solutions while tackling an issue that begins with potential problems. The teacher carefully takes students through the solution of these formal mathematics problems (Laurens et al., 2018).

Teachers are primarily responsible for educating, instructing, guiding, and assessing students. This primary responsibility will be realizable if the teacher possesses a certain level of professionalism, including the required competencies and code of ethics. However, the professionalism of teachers remains below average. According to the Institute for Management Development (2018), the quality rating of Indonesian teachers ranks fourteenth out of fourteen Asia-Pacific nations. This is evidenced by many teachers still requiring training in more diverse learning techniques (Cahyono et al., 2023; Putri et al., 2015). Many teachers still need academic credentials, so the development of teachers in Indonesia must be enhanced (Widayati et al., 2021). Due to a lack of organizational development and improvement as well as a lack of personality development and improvement (achievement motivation), many teachers still need to improve their skills (teaching abilities) (Kanawapee et al., 2022).

Law 14 of 2005 on teachers and lecturers has been in force for over fifteen years. By this law, all teachers in Indonesia should have met the requirements for their positions. But even though many teachers have met the requirements of professionalism and been given professional allowances, efforts to improve their professionalism have continued. Professional development must continue throughout a teacher's career to keep up with modern changes (Widayati et al., 2021). Planning, making tools and processes, and evaluating are all part of learning tasks (Meryansumayeka et al., 2022). Ahmad et al. (2017) explain that even examination tools can be used to teach higher-order thinking skills. It's just as important for teachers to know how to evaluate their students as it is to understand how to plan lessons and help students learn (Putri & Zulkardi, 2019). Collaborative learning allows teachers to determine their teaching flaws and strengths (Putri & Zulkardi, 2018). This makes them want to keep getting better.

Baety (2021) argues that improving teacher competence in the context of developing teacher professionalism could significantly impact how well students learn and, more generally, improve the level of education in Indonesia. Teacher professional development is recognized as the primary tool for improving the learning process quality, ultimately improving student achievement (Petrie & McGee, 2012). Professional development for teachers is also essential because teachers are the key to educational change and school growth (Richards & Renandya, 2002). Permenneg PAN and RB No. 16 of 2009 note that one way to make teachers more skilled is to have them participate in training and workshops that help them gain knowledge, skills, and other abilities.

Training or workshops encourage individuals to become more self-confident and competent in life and the workplace (Nasution, 2000). These findings imply that the workshop may help teachers acquire social norms in the mathematics classroom (Putri et al., 2015). Training or workshops can be broadly defined as acquiring knowledge, skills, and attitudes that enable humans to achieve individual and organizational objectives today and in the future. This workshop will result in positive changes for teachers, particularly in their ability to construct HOTS questions with a realistic mathematical approach (Putri et al., 2015). Several studies demonstrate that workshops can enhance the professional competence of teachers (Abdullah et al., 2016). According to the study's findings, the principal's efforts include Teacher Working Groups (MGMP in Bahasa), comparative studies, supervising learning, visiting teachers, seminars, workshops, and providing teacher motivation. Lack of adequate facilities and infrastructure, lack of awareness from teachers to increase or develop their potential, and the inability of some senior teachers to operate computers or online learning devices are impediments to school principals increasing teacher competence (Ardha et al., 2018). The next step is to engage teachers in seminars and workshops. Through participation in workshops and seminars, teachers can enhance their ability to master and implement lessons in the teaching and learning process (Handayani, 2021).

The andragogy training model is one of the numerous training models developed. The tutor serves as a guide and facilitator in the andragogy-based workshop (Aliping & Parcasio, 2018). As a guide, the tutor's role is to invigorate and motivate the participants so that a conducive interaction process can occur and they can play an active role in the training. Furthermore, Tezcan (2022) stated that the andragogy training model provides participants with comprehensive self-understanding. The andragogy model comprises the following activities: brainstorming, discussions, group work, presentations, and reflection (Kanawapee et al., 2022).

Previous research on the development of teacher professionalism through workshops has utilized three distinct learning formats: face-to-face, face-to-face, and online (blended learning), and completely online (Cahyono et al., 2019; Corell-Almuzara et al., 2021). Similarly, teacher preparation programs may employ this method. During hybrid training, the finest aspects of traditional training and online learning are combined (Cahyono et al., 2019). In hybrid training programs, participants can choose between online and in-person training to further their education based on their specific requirements. While some research suggests that virtual workshops outperform in-person ones, others disagree. According to theory, offline workshops are more effective than online ones since they allow faster learning (Cahyono et al., 2023). Based on the findings of this research, only a few workshops have used the andragogy model to train teachers to generate high-order thinking (HOTs) questions conducted both online and offline. Therefore, this study aims to develop a workshop model for middle school teachers that is valid and practical and potentially affects the HOTs ability of middle school students.

METHODS

Research Methods

This study aims to develop a workshop model for senior high school teachers that is valid and practical to potentially affect HOTs abilities in middle school students. The research method used in this research is design research of the type of development studies. This research has two stages: preliminary and formative evaluation (Bakker, 2022; Zulkardi, 2002). The flow model workshop is shown in Figure 1.

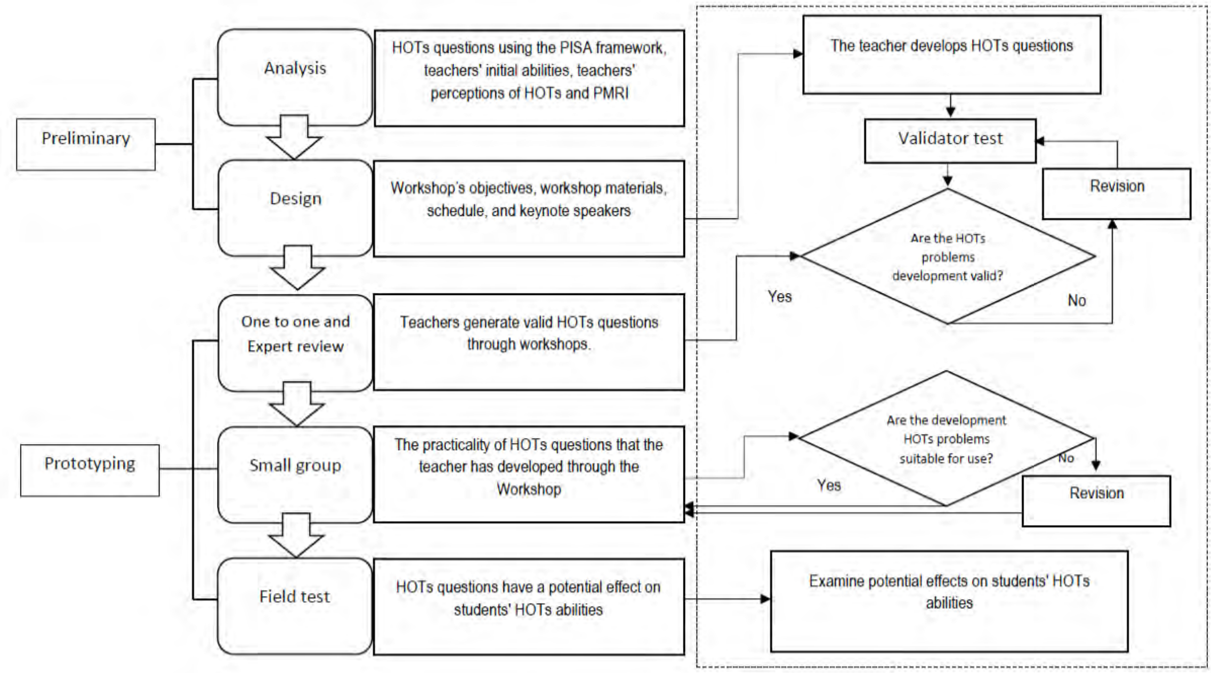


Figure 1. Workshop model development research flow

Preliminary

At the analysis stage, the researcher conducted several initial analyzes, namely: the analysis of HOTs questions using the PISA framework. Analysis of the teacher's initial ability through the results of the Teacher Competency test in East OKU Regency and the initial questionnaire on teacher knowledge regarding HOTs questions with the PMRI approach in East OKU Regency.

At the design stage, the workshop was held two times by math teachers who are members of the MGMP in East OKU Regency, totaling 65 people in the first workshop (offline), taking place in the Hall of Senior high school number Negeri 3 Martapura and 35 people in the second workshop (online) via zoom. The Workshop model used is the andragogy model, which includes in Figure 2.

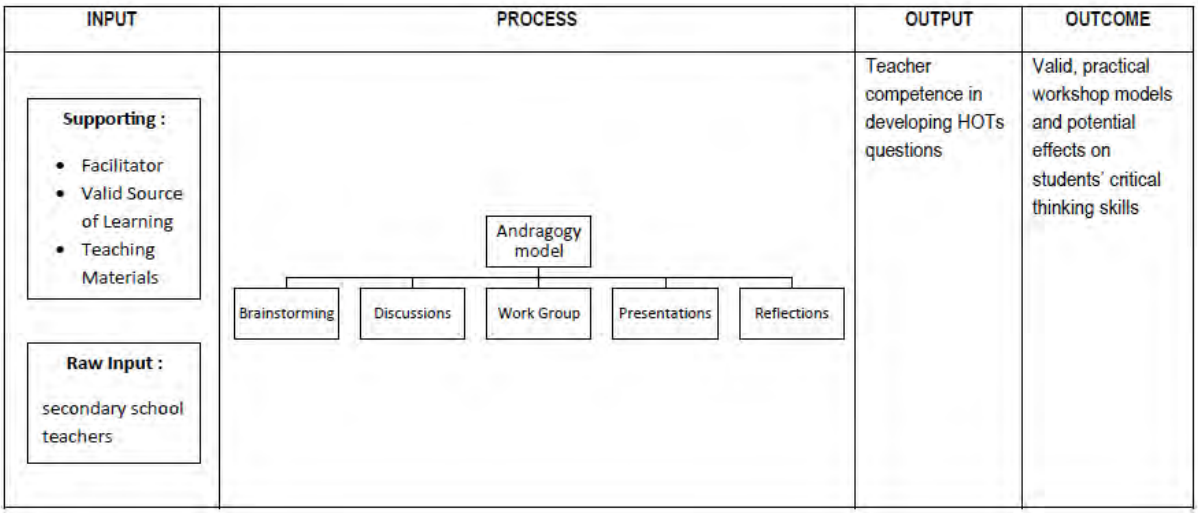


Figure 2. Schematic of the conceptual design of workshop-based andragogy model

Figure 2 shows a schematic workshop concept with the andragogy model—middle school teachers as participants in workshop activities. The andragogy model has several activities, including brainstorming, discussion, workgroup, presentation, and reflection. This workshop produces teachers who have competence in developing HOTs questions. In addition, questions developed by the teacher potentially affect critical thinking skills.

Formative Evaluation

The formative evaluation includes self-evaluation, expert review, one-to-one, small group, and field tests. Self-evaluation is self-assessment (during the workshop) of the prototype HOTs questions using the PMRI approach. The HOTs questions were validated by experts and colleagues as experts based on the three characteristics (content, construct, and language). At the expert review stage, also called the validity test stage, the HOTs questions using the PMRI approach that has been designed will be scrutinized, assessed, and evaluated by experts. This study had four experts, two people for the first workshop validation and two people for the second workshop validation.

Prototype 1, one to one evaluation, was tested on three students of class XI at SMA N 1 Martapura, Martapura Regency, East OKU Regency. Students were randomly selected with varying abilities, namely high, medium, and low abilities. Trials were conducted to see the difficulties that might occur during the learning process using teaching materials. After being tested, students were asked to comment on the teaching materials they had worked on. Suggestions from the validator and the results of the comments from one-to-one became material for the researchers' consideration to improve prototype 1 to prototype 2, which was then tested on small groups. The one-to-one and expert review results are the basis for revising the second prototype. In the small group stage, researchers discovered the second prototype's practicality. The tryout was conducted in a small group of 6 students from SMA N 1 Martapura. After being tested, students were asked to comment on the HOTS questions that were made.

In the field test, the questions that have been developed were tested in 5 (five) schools in class XI (eleven) students at SMA N 1 Martapura with a total of 30 students, SMA N 2 Martapura with a total of 36 students, SMA N 3 Martapura with a total of 32 students, SMA Madang Suku 3 with 16 students, and SMA YPPI with 11 students. Students' questions were analyzed based on indicators of critical thinking ability. The ability to think critically is interpretation to understand the meaning of a thing, analysis to better understand a case through data or information, inference to conclude a collection of data and information, evaluation to assess the credibility of the resulting conclusions, explanations in stating the truth of reasons and re-examine (Facione, 2015). In Table 1, the researcher has redefined the six indicators of critical thinking ability into descriptors.

Table 1. Critical thinking ability indicators

Indicator	Descriptor
Interpretation	Can clearly and precisely write down the problems contained in the situation
Analysis	Can write down every step used in solving the problem
Evaluation	Can write down problem-solving.
Inference	Can draw logical conclusions from what is asked
Explanation	Can explain the conclusions drawn and can write down the final results.
Self- regulation	Can review the answers that have been given/written

Table 1 indicates critical thinking skills. The indicators for critical thinking include interpretation, analysis, evaluation, inference, explanation, and self-regulation. The six indicators are further elaborated into several descriptors to analyze student answers.

Research Subject

The study subjects were math teachers who were members of the MGMP in East OKU Regency, totaling 65 people in the first (offline) and 35 in the second (online) workshop via Zoom. Students involved during the prototyping process included a one-to-one trial with three randomly selected students with various abilities, namely high, medium, and low abilities. The ability of these students is measured from the results of daily assessments owned by the teacher. The try-out was carried out in small groups consisting of 6 students from SMA N 1 Martapura which were divided into two small groups, and in the field test, namely class XI (eleven) students at SMA N 1 Martapura with a total of 30 students, SMA N 2 Martapura with a total of 36 students, SMA N 3 Martapura with a total of 32 students, SMA Madang Suku 3 with a total of 16 students, and SMA YPPI with a total of 11 students.

Data Collection and Data Analysis

Data collection techniques used in this study were walkthroughs, documents, observations, and tests. At the expert review and one-to-one stages to determine the validity of the questions in terms of content, construct, and language. Walkthrough data were obtained through comments and suggestions based on validators and students. Documents were used to obtain data about the practicality of the HOTs questions that have been made, which include the clarity and readability of the questions, then based on the list above, the researcher concludes the parts that will be corrected or revised in the set of questions on prototype 1. The instrument used was student answer sheets to evaluate and see practical questions for small groups, namely prototype 2. The test was used to obtain data about the effectiveness or a potential effect, namely prototype 3 of questions made to measure students' abilities after receiving learning with the PMRI approach. After collecting the data, researchers conducted a qualitative analysis describing each research stage's findings.

RESULTS AND DISCUSSION

Akker (1999) stated that high-quality learning aids must meet the validity, practicability, and efficacy criteria. HOTs queries must be developed with a realistic mathematical approach to satisfy these three criteria. This research was conducted in two stages: the preliminary stage, which included prototyping, and the evaluation flow stage, which utilized formative evaluation, including self-evaluation, expert review, one-to-one, small group, and field tests.

Preliminary

At the analysis stage, the researcher conducted several initial analyzes, namely: an analysis of PISA results, an analysis of the results of the teacher competency test in East OKU Regency, and an analysis of the results of the initial questionnaire about teacher knowledge regarding HOTs questions with the PMRI approach to mathematics teachers group participants in East OKU Regency. The analysis results of the PISA are as follows.

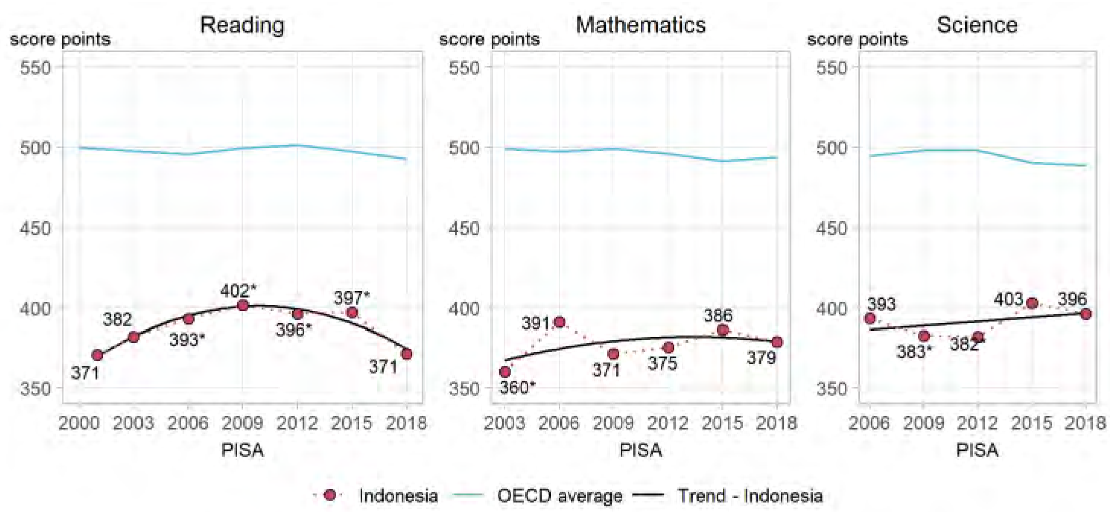


Figure 3. The trend of Indonesian performance in reading, mathematics, and science

Since 2000, Indonesia has participated in PISA, with the primary domains beginning with languages in 2000, mathematics in 2003, and science in 2006, and then sequentially continuing the following year (Figure 3). Precisely, mathematical performance has followed a hump-shaped trend. Early PISA years saw more significant fluctuations in mathematics performance, but results have been reasonably constant since 2009. A smaller proportion of Indonesian students achieved the highest proficiency levels (Level 5 or 6) than the OECD average (OECD, 2019b). 28% of students in Indonesia achieved Level 2 or higher in mathematics, meaning they can interpret and recognize, without direct instruction, how a (basic) situation can be mathematically represented. In addition, approximately 1% of students scored at or above Level 5 in mathematics, meaning they can mathematically model complex problems and select, compare, and evaluate appropriate problem-solving strategies for coping with them. This result indicates that Indonesian students were only accustomed to performing at a low level and needed to familiarize themselves with HOTs questions (Novita et al., 2012; Putri & Zulkardi, 2018; Tanudjaya & Doorman, 2020).

According to the 2022 Regional Education Balance (NPD) data, the Teacher Competency Test (TCT) results, which measure professional and pedagogical competence, are still below average, with an average of 52.57. The justification is that teachers score 54.23 for professional competence and 48.69 for pedagogic competence.

The results of the initial questionnaire regarding teacher knowledge of HOTs questions for MGMP mathematics participants in East OKU Regency showed that 45.7% of teachers were familiar with HOTs questions. However, the rest of the teachers are still not used to both working on and teaching HOTs questions in student learning in class. In addition, 80% of teachers are not used to designing HOTs questions. This is because the teacher is used to using the questions in the guidebook that has been provided.

At the design stage, the workshops were conducted offline in 2019 before the pandemic and online in the 2021 period during the pandemic. These workshops involved high school teachers in East OKU Regency. These workshops used the andragogy model with several activities, including brainstorming, discussions, group work, presentations, and reflection.

During the brainstorming, the teachers were given material by PMRI and PISA experts from Sriwijaya University. In addition, researchers also had the opportunity to share experiences in developing HOTs questions, as shown in Figure 4.

Figure 4. Brainstorming activities in the teacher professionalism development workshop

The environment for the teacher's professional development session is depicted in Figure 4. The PISA 2022 framework, original items, PISA-type development questions, the relationship between PMRI, PISA, and HOTs, and materials relevant to PMRI and best practices in school learning, are all available to teachers.

The teacher and resource person had a discussion (question and answer) following the brainstorming. As seen in Figure 5, many teachers were quite excited about the information offered by the resource people.

Figure 5. Discussion activities in the Teacher Professionalism Development Workshop

Figure 5 illustrates the atmosphere of the discussion between the teacher and the resource person. The teacher is actively and interactively involved with the resource persons. Teachers are very interested in the PISA 2022 framework because it is new. In addition, the teacher was also very enthusiastic when asked to provide solutions in solving PISA-type questions.

Teachers are grouped in small groups to produce drafts of HOTs questions. The teacher designs HOTs questions using the PISA framework, as shown in Figure 6.

Figure 6. Work activities in groups to generate HOTs question drafts

The teacher reviews the curriculum by analyzing material by the objectives of the HOTs questions developed (as seen in Figure 6). The teacher creates some content questions, exploring the local context in OKUT and the difficulty level in reasoning. Voluntarily, teachers are asked to present the results of the draft HOTs questions that have been developed in large groups, as shown in Figure 7.

Figure 7. Presentation of the results of the draft HOTs questions developed by the teacher

The outcomes of the HOTs questions jointly created in small groups by one of the professors were presented (see Figure 7). Along with displaying the prepared questions, the teacher provides additional aids, including question grids, question cards, and question assessment rubrics.

The teacher then takes a moment to consider the workshop activities conducted. Resource people offer helpful feedback and recommendations on the teacher-developed HOTs questions. As practitioners of teaching in the classroom, other teachers can also contribute ideas and comments. Table 2 lists the input results and recommendations. Through online workshops, the development of HOTs questions is ongoing.

The researcher administered a questionnaire to the teachers following the teacher professionalism session to ascertain their knowledge of how HOTs questions were developed. The session improved participants' comprehension of how HOT's questions were developed.

Figure 8. Participants' understanding of HOTs questions through workshop-based andragogy

The questionnaire was given to participants three times: before the first workshop (conducted offline/face to face), after the first workshop (offline/face to face), and after the second workshop (online/via Zoom). The results were 45.7%, 77.14%, and 85.71%, respectively (see Figure 8). Based on the above findings, the workshop offered the training participants several advantages. Teachers get new knowledge about creating HOTs questions using the PISA framework and implementing learning using these questions because of the workshops offered. Finally, training can boost teachers' readiness to welcome sustainable professional development, supporting the questionnaire's findings (Abdullah et al., 2016).

Prototyping

This stage begins with the design of HOTs questions developed by the teacher using the PMRI approach by the trainees based on the competencies students will achieve and are developed based on three principles and the five characteristics of PMRI. This question relates to quantity content, the context of East OKU Regency, which will be tested on senior high school students. The PISA 2022 questions depicted in Figure 9 are one of the PISA questions used to illustrate this research.

PISA 2022

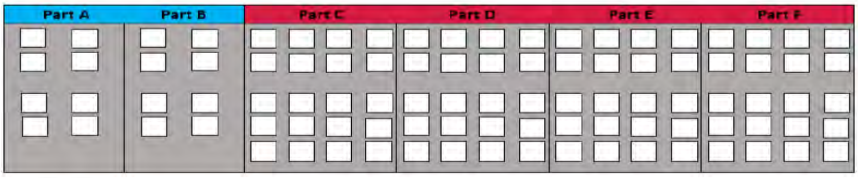
FLIGHT TICKET

Makapal Zediand has an airplane with two classes of seats Business Class and Economy Class. The number of seats and the price of each ticket for each class is shown in the table below.

Business Class	
8 seats per section (2 parts)	The price of each ticket is 600 zed (including taxes and other fees)
Economy Class	
20 seats per section (4 parts)	The price of each ticket is 250 zed (including taxes and other fees)

A seat layout on Zedland Airlines aircraft is shown below.

Business Class Economy Class



Flight Ticket

Question 1/4

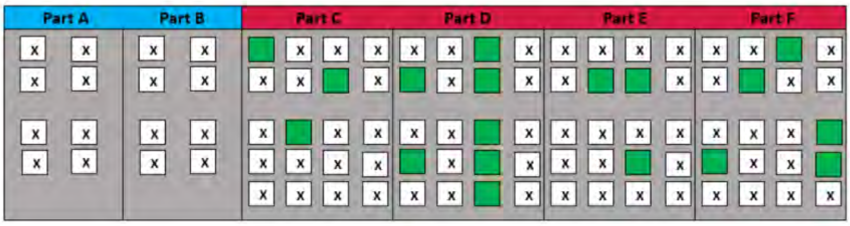
Pay attention to the text "Airline Tickets" above. Click on the one-answer option to answer the following question.

If tickets for every seat on a flight are sold at the listed price, how much money is raised from ticket sales ?

- ○ 9.800 zed
- ○ 14.600 zed
- ○ 24.800 zed
- ○ 29.600 zed

A seat layout on Zedland Airlines aircraft is shown below.

Business Class Economy Class



Flight Ticket

Question 2/4

Pay attention to the text "Airline Tickets" above. Click on the one answer option to answer the following question.

The seating chart for onward flights is shown above. Seats marked X have been sold at total price per ticket. Seats marked in green **have not** been sold.

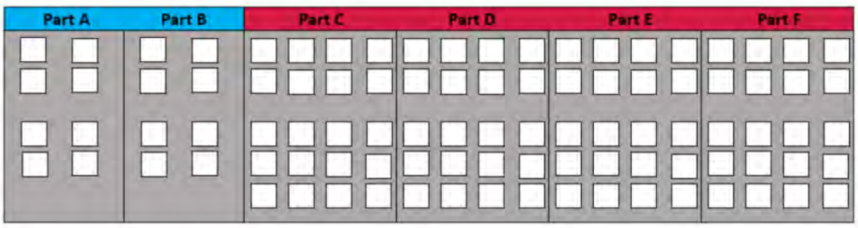
To help sell the remaining 18 tickets on this flight, the airline is giving a 20% discount for each ticket.

How much money will be collected from selling all the remaining discounted tickets?

- ○ 900 zed
- ○ 3.600 zed
- ○ 4.000 zed
- ○ 4.500 zed

A seat layout on Zedland Airlines aircraft is shown below.

Business Class Economy Class



Flight Ticket

Question 3/4

Pay attention to the text "Airline Tickets" above. Click on the one answer option to answer the following question.

To be profitable, a maximum of flights must collect at least 22,000 sed from ticket sales on each flight.

If all Business Class tickets are sold, what is the minimum number of Economy Class tickets that must be sold for a flight to be profitable ?

- ○ 30 ticket
- ○ 50 ticket
- ○ 69 ticket
- ○ 72 ticket

Figure 9. The original 2022 PISA questions with airfare context

Figure 9 is a PISA problem with number content about airplane tickets, namely ticket sales on each flight. Based on these questions, researchers will develop questions of the PISA type using the context of East OKU Regency.

At the self-evaluation stage, the researchers must first study and assess PISA-style questions and activities developed in numbers and the context of selling Duku, a typical fruit from the East OKU Regency. Several factors, including topic, construct, and language, should be considered when developing HOTs questions. The researcher with the teachers corrected the questions if there were errors such as typos, poor choice of words, or many sentences that needed to be completed. Students were subjected to HOTs questions. The researcher fixed the questions from the self-evaluation results and got Prototype 1, as shown in Figure 10.

SALE OF DUKU FRUIT

Jurnalline.com, Oku Timur, (Sumatera – Selatan) – Daerah Ogan Komering Ulu Timur Memasuki masa panen raya buah duku Oku Timur, (17/01/2019).

When the duku harvest season arrives, it is the time that the people of OKU East have been waiting for, both duku farmers and duku fruit sellers on the roadside and the people of OKU East, to enjoy it. Mr Hasan has several duku trees in his garden, ready to be harvested. After they are harvested, Mr Hasan gets 1.5 quintals of duku fruit, then separates the duku into two parts, and he finds that 60% of the duku are in quality A (Good) and 40% are in quality B (Medium). Duku fruit from Pak Hasan's harvest was all purchased by Mr Basri as a retail duku fruit seller for IDR 8,000 for quality A and IDR 6,000 for quality B per 1 kilogram.

a. How many kilograms of Duku fruit of quality A and B did Mr Hasan harvest ?
b. How much money did Mr Hasan get after selling his Duku fruit crops?
c. Mr Basri managed to sell out his Duku fruit for Rp for three days IDR 10,000 for quality A and IDR 8,000, for quality B per 1 kilogram. However, 5 kg of B-quality duku could not be sold because some were rotten and broken. How much profit did Mr Basri get after the duku sold out ?
d. Heri had IDR 50,000 in cash, and after school, he wanted to buy 3 Kg of quality A duku and 3 Kg of B quality duku at Pak Basri's stall. Is Heri's enough money to buy the duku he wants ?

Figure 10. Prototype 1 of HOTs question on quantity content

Rephrasing statements to make them more powerful, fixing mistakes, and updating the applicability table on activity questions are all examples of personal changes. The modifications made to prototype one during the self-evaluation phase will also be applied to the expert review and one-to-one phase.

Expert Review and One-to-One

Following creating questions and activities in Prototype 1, expert and one-to-one validation was utilized to provide legitimate questions and activities for content, constructs, and language (Zulkardi et al., 2020). The PISA framework should be examined concerning content to ascertain whether the questions and activities are pertinent to the assessed subject, indicators of numeracy proficiency, and numerical content. For determining whether questions and activities are suited to the ability level of secondary school students, the PISA framework includes problem levels, questions, tables, examples, etc., presented clearly, and practically. Additionally, the phrases used are precise and unambiguous, do not lead to various interpretations, and are communicative to identify the words in the questions and practice using the appropriate language. The researcher also conducted FGD and one-to-one expert evaluation to examine comments and ideas on questions and to hear what students thought. At the same time, they worked on Prototype 1 questions and activities. Based on feedback and suggestions from Prototype 1 and the outcomes of expert review and face-to-face sessions, researchers revised the questions and activities for Prototype 2.

Table 2. Comments, suggestions, and revision decisions

Validation	Comments and Suggestions	Revision Decision
Workshop Experts	1. Adjust the information in the questions with the contents of the news 2. Add news sources 3. Information at the beginning should be shortened 4. Word writing needs to be adjusted to the Perfected Spelling 5. Questions (c) and (d) seem camouflaged. Adjust them to the original PISA questions 6. Pay attention to the level of difficulty in making questions	1. The questions have been adapted to the news 2. News source has been added 3. Information has been shortened and clear 4. The writing of the words in the questions has been adjusted to the Perfected Spelling 5. Questions (c) and (d) have been replaced 6. The level of questions is adjusted in making questions
Experts Online	1. The source of the news has yet to be listed. It is better if it is added so that the news does not seem contrived 2. Writing words in questions does not use Perfected Spelling properly 3. The information on the questions could be shorter and more functional. It should be deleted or replaced to make it easier for students to understand 4. Information on questions should be made in tabular form to make it easier for students to understand the questions 5. pay attention to the difficulty level of the questions. It looks like questions (a) to (d)	1. Source has been added 2. The sentences in the questions have been corrected according to the Perfected Spelling 3. The question information has been revised 4. Question information is added in tabular form according to the validator's directions 5. The questions have been adjusted to the level of difficulty, and questions (c) and (d) have been replaced

Students	1. Students still have difficulty understanding sentences in questions, so students cannot answer questions properly 2. Questions (c) and (d) are difficult for students to understand	1. The questions have been replaced so that students understand the meaning of the questions 2. Questions (c) and (d) have been replaced

Table 2 explains that all advice supplied by experts and students regarding formulating questions and activities is valuable. However, subsequent iterations must be enhanced. Prototype 1 has been qualitatively valid based on content, construct, and language. This is reflected in parallel input and suggestions from experts and students. Using context in mathematics learning is essential because it can present abstract mathematical problems in a representation that students easily understand. (Putri & Zulkardi, 2020). The phenomena or conditions can be used as a starting point for learning and finding solutions to a problem (Zulkardi & Putri, 2019; Van Galen & Van Eerde, 2018). A learning tool that has good validity is the tool that can measure student abilities that should be mastered by the learning content listed in the learning indicators.

Small Group

Figure 11 shows the results of the small group's use of prototype two and the expert review stage repair of prototype 1, which were worked on individually.

SALE OF DUKU FRUIT

Jurnalline.com, Oku Timur, (Sumatera – Selatan) – Daerah Ogan Komering Ulu Timur Memasuki masa panen raya buah duku Oku Timur, (17/01/2019).

Source : https://www.jurnalline.com/2019/01/daerah-oku-timur-panen-raya-buah-duku/

Mr. Hasan has several duku trees in his garden, ready to harvest. After harvesting, Mr. Hasan gets 1.5 quintals of duku fruit, and then he separates the duku into two parts in the table below.

Duku Fruit Quality A	
The price of duku fruit is IDR 8,000/kg	60% of duku with a total of 1.5 quintals of duku
Duku Fruit Quality B	
The price of duku fruit is IDR 6,000/kg	40% of duku with a total of 1.5 quintals of duku

a. How many kilograms of duku fruit of quality A and quality B did Hasan manage to harvest ?
b. How much money did Pak Hasan get after selling his duku fruit harvest?
If quality A duku has been sold at an average price of 1/3 of the total duku and quality B duku has been sold at a standard fee of 1/6 of the total duku. To help with the remaining unsold duku, Mr Hasan gives a 20% discount for every purchase of 1 kg of duke.
c. How does Mr Hasan calculate the money collected from the remaining duke that has been given a discount per kilogram ?
To make a profit, Pak Hasan needs to collect at least IDR 970,000 from selling duku fruit per kilogram.
If all duku at quality A sold as much as 80 kg and duku at quality B sold as much as 55 kg. Do you agree ? Is there another answer so that Mr Hasan can get a profit, provided that the gain is not more than IDR 1,000,000? Give your reasons.

Figure 11. Prototype 2 of HOTs Question on Quantity Content

The resulting prototype two is depicted in Figure 11. Senior high school number 1 Martapura students were involved in a small group of 6 students split into two smaller groups. Students were asked to remark on the developed HOTS questions after being tested. Some students believed that the HOTs questions were engaging to work on and simple to resolve rationally. This is because most students believe that sound thinking is necessary when attempting HOTs questions. The HOTs questions are also highly like the issues people encounter daily. Because it is simple to use and comprehend for students, prototype 2 is functional. This is in line with the outcome of the small group, where the difficulties could be easily used, administered, and correctly evaluated by the students, demonstrating the practicality of the problem (Zulkardi & Putri, 2006). Practicality means that the product is easy to use by users, in this case, teachers and students.

Field test

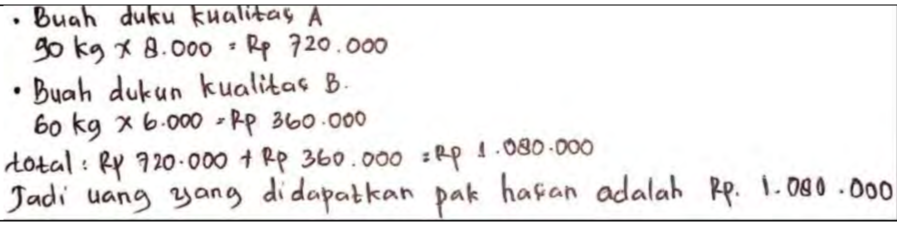
In the field test, the HOTs questions that have been developed were tested in 5 (five) schools in OKUT regency. The results of student work are analyzed and tabulated in Table 3.

Table 3. Student Scores based on learning outcomes category

No	School Name	Frequency			
		Excellent	Good	Enough	Less
1	SMAN 1 Martapura	3	5	20	2
2	SMAN 2 Martapura	2	6	21	1
3	SMAN 3 Martapura	5	7	16	1
4	SMA MUH Martapura	1	4	3	7
5	SMA YIS Martapura	-	3	1	6

Table 3 was the result of students' work on the HOTs questions given. Most students were in enough category. SMA MUH Martapura and SMA YIS Martapura have the highest score for the lower category. The excellent category has the highest score at SMAN 2 Martapura, SMAN 3 has the highest score for the good category, and the excellent category at SMAN 3 Martapura. In brief, the dominant for better schools is SMAN 3 Martapura because it is included in the excellent category and good category; schools in the good category are SMAN 2 Martapura, and the lower category is SMA MUH Martapura and SMA YIS Martapura.

The following are some of the student's answers to the field test results, which show how students' critical thinking skills are displayed when answering the following questions.



Translation:

- Duku fruit quality A
  $90\ kg \times Rp\ 8{,}000 = Rp\ 720{,}000$
- Duku fruit quality B
  $60\ kg \times Rp\ 6{,}000 = Rp\ 360{,}000$

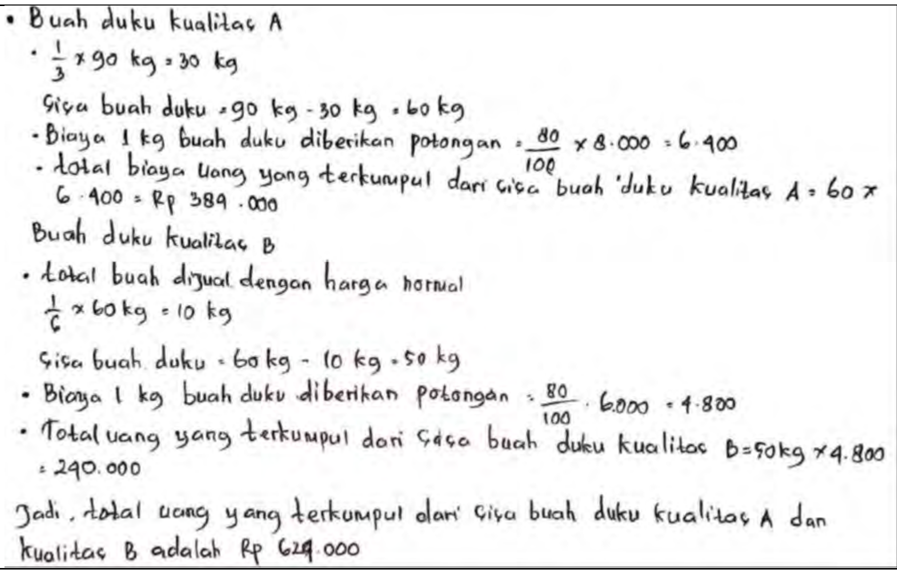
} Interpretation Analysis

Total: $Rp\ 720{,}000 + Rp\ 360{,}000 = Rp\ 1{,}080{,}000$ → Evaluation

So, the money Mr Hasan got was $Rp\ 1{,}080{,}000$ → Inference

Figure 12. Student's solution to question number 1

Figure 12 shows that students solved the problem correctly. Students could determine how much money Pak Hasan got after selling all his duku fruit crops using multiplication and addition operations. In this situation, interpretation indicators appeared by writing down the problem by determining the number of duku at quality A. The number of duku at quality B. Student analysis indicators can select the money Mr. Hasan earns each on duku quality A and quality B. Student evaluation indicators can add up the money Mr. Hasan got by selling duku fruit. Students can determine the result for inference indicators, namely how much money Mr. Hasan got.



Translation:

Duku fruit quality A

- Total fruit sold at normal price
  $\frac{1}{3} \times 90\ kg = 30\ kg$
  The remaining duku fruit $= 90\ kg - 30\ kg = 60\ kg$
- The cost of 1 kg of duku fruit is given a discount $= \frac{80}{100} \times 8{,}000 = 6{,}400$

} Interpretation Analysis Evaluation

- The total money collected from the remaining duku fruit of quality $A = 60\ kg \times Rp\ 6{,}400 = Rp\ 384{,}000$

} Explanation

Duku fruit quality B

- Total fruit sold at normal price
  $\frac{1}{6} \times 60\ kg = 10\ kg$
  The remaining duku fruit $= 60\ kg - 10\ kg = 50\ kg$
- The cost of 1 kg of duku fruit is given a discount $= \frac{80}{100} \times 6{,}000 = 4{,}800$
- The total money collected from the remaining duku fruit of quality $A = 50\ kg \times Rp\ 4{,}800 = Rp\ 320{,}000$

So, the total money collected from the remaining duku fruit of quality A and quality B is $Rp\ 624{,}000$

Interpretation
Analysis
Evaluation

Explanation

Inference
Self- regulation

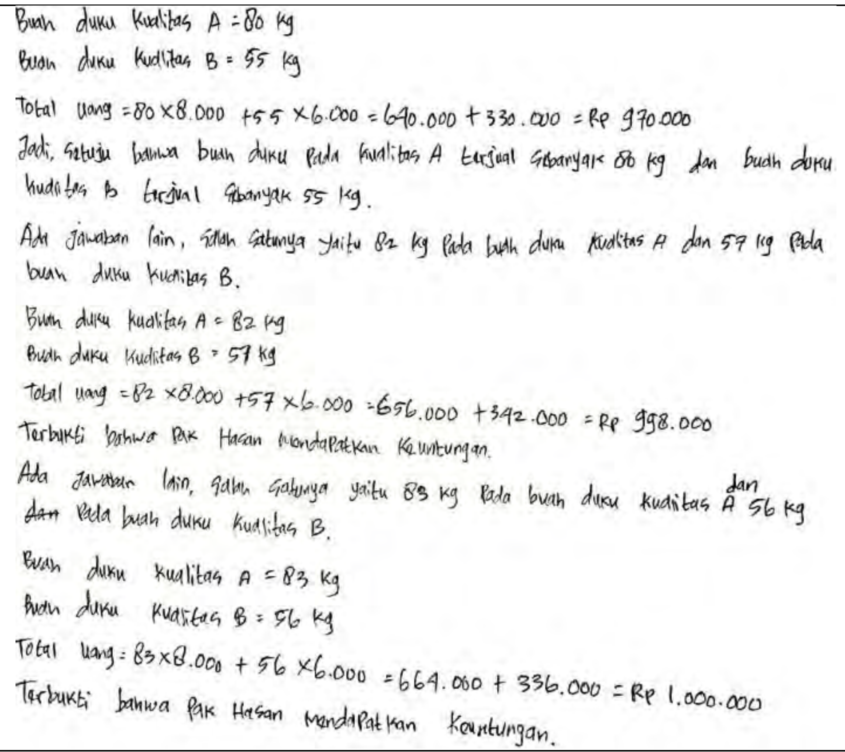
Figure 13. Student's solution on question number 2

Figure 13 illustrates that students can answer them by reasoning, that is, to get Mr. Hasan's way of calculating the money collected from the remaining duku fruits, which have been given a discount per kilogram. Critical thinking indicators appear, namely, Interpretation indicators, writing down the problems contained in the situation by determining duku fruit students for each duku quality A and B. For Analysis indicators, students can write down each step in solving the problem by determining the total amount of money collected from the rest of quality A duku and quality B duku. For evaluation indicators, students can write down the completion of the problem, namely the cost of 1 kg of duku given a discount and the total money for each duku quality A and quality B. Explanation indicators, students can write down the results end correctly. Indicators of self-regulation students can review the answers given/written by determining the outcome of the total money collected from the remaining duku of quality A and quality B.

Figure 14 depicts students can answer it by reasoning, namely determining the profit Mr. Hasan will get from selling duku fruit by choosing much quality A duku fruit and a lot of B quality duku fruit first. Students can calculate the money that Mr. Hasan will obtain with their respective benefits and, with the conditions specified in the questions, can use addition and multiplication operations to determine whether the required profit can be fulfilled with the correct explanation. Then students can compare the number of fruits on the quality of duku A and duku on quality B.

An indicator of critical thinking appears, an interpretation indicator: students can write down how many duku are of quality A, and quality B. Student evaluation indicators can determine the amount of money if they sell duku of quality A and sell as much as 80 kg of duku of quality B and sell as much as 55 kg. The student explained that 80 kg of quality A duku and 55 kg of quality B duku fruit were sold. Student analysis indicators found that other answers were wrong, so profits exceeded sales of the desired duku fruit. Moreover, student self-regulation indicators can review the solutions given/written to get a profit, provided that the gain is not more than Rp. 1,000,000, so it is proven that Mr. Hasan made a profit.

Indicators of professional teacher success can be seen in the quality of the process and student learning outcomes, which is already the responsibility of a personal teacher. In addition, the level of teacher professionalism can be marked by the mastery of competence as a teacher, both academically and in the authentic context of providing services to students for whom he is responsible. Baety (2021) explains that the quality of education and teacher professionalism are interrelated, so the two cannot be separated, especially in achieving educational goals. Teacher professionalism influences the quality of education because the teacher determines the success and failure of a learning process, which will affect students' future (Cahyono et al., 2023; Putri et al., 2015).


Buah duku kualitas A = 80 kg
Buah duku kualitas B = 55 kg
Total uang = 80 × 8.000 + 55 × 6.000 = 640.000 + 330.000 = Rp 970.000
Jadi, setuju bahwa buah duku pada kualitas A terjual sebanyak 80 kg dan buah duku kualitas B terjual sebanyak 55 kg.
Ada jawaban lain, salah satunya yaitu 82 kg pada buah duku kualitas A dan 57 kg pada buah duku kualitas B.
Buah duku kualitas A = 82 kg
Buah duku kualitas B = 57 kg
Total uang = 82 × 8.000 + 57 × 6.000 = 656.000 + 342.000 = Rp 998.000
Terbukti bahwa Pak Hasan mendapatkan keuntungan.
Ada jawaban lain, salah satunya yaitu 83 kg pada buah duku kualitas A dan 56 kg ~~dan~~ pada buah duku kualitas B.
Buah duku kualitas A = 83 kg
Buah duku kualitas B = 56 kg
Total uang = 83 × 8.000 + 56 × 6.000 = 664.000 + 336.000 = Rp 1.000.000
Terbukti bahwa Pak Hasan mendapatkan keuntungan.

Translation:
Duku fruit quality A $= 80\ kg$
Duku fruit quality B $= 55\ kg$
Interpretation

Total money
$= 80 \times 8{,}000 + 55 \times 6{,}000 = 640{,}000 + 330{,}000 = Rp\ 970{,}000$
So, it is agreed that duku fruit in quality A sold as much as 80 kg and duku fruit in quality B sold as much as 55 kg
Evaluation *Inference*

There are other answers, one of which is 82 kg for quality A duku fruit and 57 kg for quality B duku fruit.
Interpretation

Duku fruit quality A $= 82\ kg$
Duku fruit quality B $= 57\ kg$
Total money $= 82 \times 8{,}000 + 57 \times 6{,}000 = 656{,}000 + 342{,}000 = Rp\ 998{,}000$
It is proved that Mr Hasan has benefited.
Analysis

There are other answers, one of which is 83 kg for quality A duku fruit and 50 kg for quality B duku fruit.
Duku fruit quality A $= 83\ kg$
Duku fruit quality B $= 56\ kg$
Total money
$= 83 \times 8{,}000 + 56 \times 6{,}000 = 664{,}000 + 336{,}000 = Rp\ 1{,}000{,}000$
It is proven that Mr Hasan has benefited.
Self-regulation

Figure 14. Student's solution to question number 3

Workshop with andragogy model positively influences teacher professionalism in developing HOTS questions with the PMRI. The increase in knowledge was better, 31.44% (from 45.7% to 77.14%), while the increase in command in the second workshop was 8.57% (from 77.14% to 85.72%). This is because the interactivity in sharing experiences between teachers and resource persons has a good impact on developing teacher competence. In line with that, workshop interactivity helps teachers develop pedagogic and social skills (Aliping & Parcasio, 2018; Putri & Zulkardi, 2019).

During the workshop, the teacher collaborates with the students in small groups to create HOTs questions. This partnership aids in the growth of a teacher's abilities as a designer of classroom learning and a teacher. Putri and Zulkardi (2019) said that the teacher's job is to construct learning materials that are appropriate for each student's skill level in addition to teaching in the classroom.

In designing HOTs questions, teachers need to use local contexts close to students. In this case, the context of selling duku fruit is a typical plant in OKUT Regency. Using the local context helps students understand and work on the questions (Zulkardi & Putri, 2006). Since the challenges apply to daily life, students are more motivated to complete them. Learning is more meaningful when students solve issues near them (Putri & Zulkardi, 2019).

The questions' problems can be precisely recorded using the interpretation indicator (interpretation) with the descriptor. This is demonstrated by being able to write down the issues that arise when addressing HOTs math problems, namely identifying the number of duku at quality A and quality B and calculating sales results from duku fruit quality A and quality B. Students interpret the HOTs problems by rewriting the critical information in the questions. Students can interpret the meaning of the problem by writing down the general information and asking about the problem. This is because the situations given are relevant to their daily lives. In line with that, Nusantara et al. (2021) found that students could interpret questions when they could identify relevant information by adapting situations to their daily experiences. Understanding situations relevant to their life in each problem can help them interpret and solve problems (Novita et al., 2012). Using context leads students to think mathematically because their potential for mathematical thinking processes emerges from the given situation. Furthermore, using context will provoke students to be involved in collaborative learning, making learning meaningful (Putri & Zulkardi, 2020).

You can record each step to solve the problem in the analysis indicator with a descriptor and indicator (evaluation) with a descriptor. You can write down the problem-solving. Students analyze the HOTs problem given by writing down each step used in solving the problem and writing down the problem-solving. Thus, the apparent mathematical process is a strategy for integrating various information to get a solution. This process arises because students with good reasoning abilities can correctly incorporate the stages of understanding, formulating, and solving problems (Meryansumayeka et al., 2022). In addition, understanding real-world problems is essential early in translating and interpreting PISA problems (Nusantara et al., 2021).

Inference indicator, see if students can conclude logically from what is asked, and students can explain the conclusions drawn and can write down the results. When students can conclude how to solve a problem, they have a solid understanding of the issue. Zulkardi et al. (2020) stated that students who understand and respond to problems follow distinct procedures: solving problems, looking at the photographs, reading the questions, and comparing all the material.

In the self-regulation indicator, students can review the answers given/written. However, it is seen that they spend more extended time understanding the question sentence than identifying important information about the question. This condition made them make mistakes in reviewing answers with calculations. In contrast, Cahyono et al. (2019) stated that students made mistakes in changing the questions into arithmetic processes because they needed to read them correctly. They only focus on question descriptions, needing help understanding the main problem (Zulkardi et al., 2020).

Using context as a learning resource helps students combine other problems with problem-solving. Consequently, they can work mathematically and relate ideas from different subjects to solve problems. This is also supported by several researchers who say that phenomena or conditions can be used as a starting point for learning and solutions to a problem (Zulkardi & Putri, 2019).

CONCLUSION

The workshop with the andragogy model developed had a positive and significant impact on the understanding and ability of the teachers to develop HOTS questions using the PMRI approach. Using the PMRI approach, teachers could explore the local context—in this specific case, the sale of duku, a fruit indigenous to OKUT Regency—to develop HOTs questions. Employing context closed to students also made it easier for them to reason critically when solving HOTs questions by allowing them to model problems in their ways.

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