




Development of AKM-Based Mathematics Questions in the Adiwiyata Context to Train Students' Numeracy Skills

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Abstract

This study aims to produce AKM-based mathematics questions in the Adiwiyata context that are valid and practical and potentially affect the numeracy abilities of class X and XI MA students. The research method used is a development studies type design, which consists of two stages: the preliminary and formative evaluation. Data collection techniques used were walk-throughs, interviews, questionnaires and tests. The validity of the questions is obtained from the results of the validator's assessment in terms of content, construct, and language at the expert review stage and the clarity and readability of the questions based on students' comments and suggestions at the one-to-one stage. The practicality of the questions is obtained at the small group stage based on the questionnaire results. The potential effect of questions is obtained at the field test stage based on test and questionnaire results. This research produced 30 mathematics questions based on AKM contexts that were valid and practical and potentially affected numeracy abilities. The results of testing mathematics questions based on AKM in the Adiwiyata context showed that 44.87% of the 156 (26 students x 6 questions) analyzed answer items were identified as correct answers. As many as 44.23% of the 52 subjects (26 students x 2 questions) could solve knowing-level questions. As many as 48.7% of 78 subjects (26 students x 3 questions) could solve questions at the applying cognitive level, and 42.3% of 26 (26 students x 1 question) subjects could solve questions at the cognitive reasoning level.

INTRODUCTION

Minimum Competency Assessment (AKM) is one of the breakthroughs in education from the Indonesian government. One of the backgrounds for implementing AKM in Indonesia is to boost the PISA (Program for International Student Assessment) scores, the achievements of which are still below the average of OECD (Organization for Economic Cooperation and Development) countries. In 2018, the PISA score in mathematics competency was 379 points, while the average score for OECD countries was 487 [1]. This AKM replaces the role of the National Examination (UN) as a source of information for mapping and evaluating the quality of the education system in a region but does not replace the role of the National Examination, which evaluates student achievement or learning outcomes as a whole [2], AKM is a measure of

literacy and numeracy achievements used to map quality education in Indonesia with international standards, the characteristics of AKM questions are also adapted from PISA questions. This aims to make students familiar with PISA questions so that in the future, it is hoped that they will be able to boost their PISA rankings and compete with other OECD countries.

The importance of AKM as a student assessment is that students are accustomed to not only being able to write words or sentences from texts written by other people, but also students must be able to convey their thoughts to other people in writing using excellent and polite choices of words and sentences, of course by Indonesian language rules. In calculating skills, students cannot only operate numbers (adding, dividing, subtracting, and multiplying) but must be able to use them to solve daily life problems related to numbers [2]. This AKM aims to improve the quality of learning in Indonesia and measure students' cognitive learning outcomes, including reading and numeracy. [3], as well as realizing 21st-century skills or life skills [4]

AKM numeracy is an assessment that measures the ability to think using concepts, procedures, facts, and mathematical tools to solve everyday problems in various contexts relevant to individuals as citizens of Indonesia and the world [5]. Steen stated that numeracy is contextual and concrete and offers contingent solutions to real-life problems [6]. Numeracy abilities include skills in applying mathematical concepts and rules in real situations in everyday life (contextual). Based on Han et al. Numeracy indicators are 1) using various kinds of numbers and symbols related to basic mathematics to solve problems in various contexts of daily life, 2) analyzing information displayed in various forms (tables, graphs, charts, diagrams and so on), 3) interpreting analysis results in order to predict and make decisions [7].

According to the Ministry of Education and Culture's Pusmenjar, cognitive processes and context are the basis for assessing numeracy abilities. The cognitive process is related to understanding concepts that can be used to reason in solving problems, while the context in assessing numeracy abilities is related to personal, socio-cultural, and scientific contexts [7]. Numeracy context includes scientific information, family, work, recreation, citizenship, and culture [8]. Personal context is a context related to the activities of a person, family or group. Examples of personal context include hobbies, daily activities and needs, personal health, and personal scheduling. Meanwhile, the socio-cultural context relates to Indonesian culture, society, traditional games, community, and societal issues.

Meanwhile, the scientific context consists of intra-scientific, closely related to mathematics, and extra-scientific, related to other scientific disciplines. Apart from that, the characteristics of the AKM Numeracy questions are usually preceded by stimuli with various contexts and themes, such as decent work, economic growth, gender equality, quality education, clean water and adequate sanitation, responsible consumption and production, sustainable cities and settlements, and ecosystems. Land, ocean ecosystems, peace, justice, strong institutions, partnerships to achieve goals, and healthy and prosperous lives [9], including the environment or *Adiwiyata*.

Nowadays, the environment is a problem that needs serious attention. The environment is starting to be threatened by various impacts caused by various human activities, such as landslides caused by deforestation, air pollution caused by vehicle fumes and factory fumes, forest fires due to excessive exploitation without compensating for maintenance actions, and

floods due to piles of rubbish. Moreover, waste from housing is not managed correctly. The environment shows significant changes From year to year, such as extreme weather changes, global warming, etc. Environmental issues are extensive because the complexity of the problems involves important and diverse aspects from multidisciplinary sciences such as economics, politics, society, and culture and includes groups of exact sciences.

Along with population and industrial growth, environmental issues have become a severe problem humans face [10]. Therefore, taking preventive measures by participating in environmental conservation that must be implemented early is very important. Schools are important places that can be used as a forum for providing education about the environment, according to Wolley [11]. Schools have a significant role in securing the future of the younger generation; as places of learning, schools and teachers can help students understand the impact of human activities on the earth. School is an excellent place to practice sustainable living and working habits. Even the future solutions to world problems are in the hands of the younger generation. Education is also the right way to form individuals who instill discipline and independence in everyday life. For this reason, the government is committed through the Minister of Environment Regulation Number 5 of 2013 to the management and protection of the environment through education, namely by issuing a policy regarding the Adiwiyata program.

Adiwiyata is a program of Environmental Education (PLH) initiated by the Ministry of the Environment, which is aimed at encouraging the creation of knowledge and awareness among school residents to preserve the environment to form and realize responsibility and concern for the environment [12].

The Ministry of the Environment and the Ministry of Education and Culture explained that the Adiwiyata program aims to create responsible school citizens to provide environmental protection and management through good school governance to support sustainable development [13]. The government's hope for the Adiwiyata school is that it can become a place for school residents to gain knowledge, norms, and ethics as a basis for creating a prosperous life and moving towards the ideals of sustainable development. So, in the future, school residents are expected to be directly involved in school activities that promote a healthy environment, preserve the environment, and avoid behaviour that hurts the environment. According to Maryani [13], there are two principles in implementing the Adiwiyata program: 1) participatory, all school members must be directly involved in the Adiwiyata Program process, which includes planning, implementation and evaluation according to their respective responsibilities and roles. 2) Sustainable, meaning that all activities of the Adiwiyata Program must be implemented comprehensively and continuously. There are four indicators of the Adiwiyata Program according to the regulation of the Minister of the Environment of the Republic of Indonesia No. 5 of 2013, namely: 1) aspects of school policy that are environmentally friendly, 2) aspects of environmentally based school curriculum, 3) aspects of participatory based school activities and 4) aspects of managing environmentally friendly school supporting facilities and infrastructure.

The delivery of materials related to environmental education to students is carried out through an integrated curriculum. Developing various materials, models and learning methods provides students with an understanding of material content and the living environment related to daily life, including making questions or learning evaluation instruments that must be integrated with the Adiwiyata program. Based on this, the researcher plans to develop AKM

Numeracy questions in the Adiwiyata context to be a reference for students to learn and get used to working on AKM-based questions while providing education about the environment.

Some research on Adiwiyata has become an exciting topic, including the implementation of an environmentally friendly school culture which contains values that are very valuable for education, such as the value of loving the environment, the value of caring for the environment, as well as the value of the spirit of achievement [10], there are differences in environmental knowledge, and there are differences in the attitude of caring for the environment in high school students. Adiwiyata and non-Adiwiyata high schools [14], there is a positive influence of problem-solving skills and environmentally caring character on problem-solving abilities [15], the level of creative thinking of students in solving Adiwiyata-based mathematics problems is at a creative level by showing indicators of creative thinking, fluency and flexibility [16].

Supported by previous research, Indonesian students' numeracy skills are still low [7]. Students with high, high and medium initial mathematics abilities could only meet some problem-solving and numeracy indicators. In contrast, students with low and meagre abilities could not fulfill the problem-solving and numeracy ability indicators at all [17]. Students in the low numeracy ability category have difficulty implementing reading in questions in the form of algebra or geometry. Students in the medium category like story problems and questions with contexts related to everyday life, but students in this category are still hampered in working on questions because formulas constrain them.

Meanwhile, students with high numeracy ability categories can explore and implement abilities and understanding but still have a little difficulty solving questions with types of questions that require more understanding and reasoning because they take up time in the process [18]. On the other hand, the AKM Numeracy results are still far from expectations. Based on the 2021 SMA/MA AKM Numeracy results, the national average score in numeracy ability is 1.7 (range 1 – 3), with achievements below the minimum competency.

Based on this, the researcher plans to develop AKM-based mathematics questions in the Adiwiyata context that are valid, practical and have potential effects with the hope that the questions developed can be used as a practice reference for students in exploring and getting used to working on AKM-based questions while providing education about the environment.

METHODS

The method used in this research is design research with the type of development studies. This research has two stages, namely the preliminary stage and the formative evaluation stage, which consists of the self-evaluation stage, expert review and one-to-one, small group, and field test [19]. The research subjects were MAN 2 Tasikmalaya class X and XI students, and the study was carried out from January to June 2023. The data collection techniques were walk-through, interviews, questionnaires and tests. Questionnaires are used to determine student responses in solving questions, and tests are used to determine numeracy abilities in solving problems.

At the preliminary stage, AKM framework analysis, student analysis and question design were carried out. The questions that have been designed are evaluated independently at the self-evaluation stage and then analyzed to become prototype 1.

In the expert review stage, experts evaluate, review, and assess prototype one. Expert validation is aimed at analyzing according to content, construct and language. Prototype 1 was

given to Rosuli (preparer of the National AKM questions in 2020, author of the book "Fokus AKM Numerasi SMA/MA" Erlangga publisher in 2020, author of the book "Xpres AKM Numerasi SMA" in 2022 Erlangga publisher, author of the book "Fokus SNBT SMA" in 2022 Erlangga publisher), Fuad Hidayat (Indonesian Madrasah Competency Assessment Instructor), Aso Juharso (Mathematics teacher and head of the Adiwiyata curriculum). Data collection in this stage was carried out by walk through via Google Meet and Zoom.

Simultaneously with the expert review stage, researchers tested individual students at the one-to-one stage against three students with different abilities: one with high ability, one with medium ability and one with low ability. The focus at this one-to-one stage is to see the clarity and readability of the questions. The expert review and one-to-one results were used as the basis for revisions to produce prototype 2.

Prototype 2 was tested on six students with different abilities: two with high abilities, two with medium abilities and two with low abilities at the small group stage. This small group stage focuses on finding the practicality of the developed questions taken from questionnaire responses. The results of this small group stage were used as material for revising prototype 2 to become prototype 3.

Prototype 3 was tested on 26 students from grades 10 and 11 with different abilities at the field test stage. This field test stage focuses on determining the potential effect of the questions developed on students' numeracy abilities. Students' answers were analyzed based on indicators of numeracy ability to determine emerging numeracy abilities.

The data generated from the questionnaire is calculated to determine the category and describe it. The student response questionnaire was measured using a Likert scale with five answer choices, namely as follows.

Table 1. User response questionnaire score categories

Score	Category
5	Very good
4	Good
3	Enough
2	Not enough
1	Very less

The steps to determine the interpretation are as follows [20]:

- Determining the maximum score (S_{\max})
 $S_{\max} = \text{number of questionnaire items} \times \text{number of respondents} \times 5$
- Determining the minimum score (S_{\min})
 $S_{\min} = \text{number of questionnaire items} \times \text{respondents} \times 1$
- Specifies the range
 $\text{Range} = \text{maximum score} - \text{minimum score}$
- Determining the class length (p)
- Determine the response scale

Table 2. Interpretation of Response Scales

Total Score	Interpretation
$S_{\min} \leq ST < S_{\min} + p$	Very Bad
$S_{\min} + p \leq ST < S_{\min} + 2p$	Bad
$S_{\min} + 2p \leq ST < S_{\min} + 3p$	Enough
$S_{\min} + 3p \leq ST < S_{\min} + 4p$	Good
$S_{\min} + 4p \leq ST < S_{\max}$	Very good

RESULTS AND DISCUSSION

This research produced 32 mathematics questions based on AKM in the Adiwiyata context, 13 stimuli including the flood disaster in Indonesia, Biopori, Waste Bank, classroom equipment, Ecobricks, determining the selling price of craft products, packaging boxes, saving water, fruit soup, smoking is the leading cause of death and disease, smoking and the Covid-19 pandemic, school gardens, and cultivating vegetable plants at school. The 32 questions consist of 10 data and uncertainty content, 10 number content, eight algebra content and six geometry content. However, only two units of questions with the stimulus titles "Trash Bank" and "Classroom Equipment" are discussed in this article.

Preliminary Stage

At this stage, the researcher determined MAN 2 Tasikmalaya as the research location and classes 10 and 11 as the research subjects. Researchers conducted unstructured interviews with several grade 11 students who had taken AKM and several mathematics teachers related to AKM numeracy, analyzing the Adiwiyata curriculum, student analysis and AKM framework analysis. Next, the researcher designed a question instrument based on the characteristics of AKM questions in the Adiwiyata context, consisting of a question grid, question cards and assessment rubrics. The result of this preliminary stage is an initial prototype. The questions produced in the initial prototype were two stimuli consisting of 8 questions. The following explains the two stimulus units at the preliminary stage.

In stimulus 1, the researcher developed AKM-based questions with the stimulus title "Trash Bank". The content used was numbers consisting of 3 questions. The competency uses operations on integers, including estimating the results of operations. Question 1 asks about the profits the Waste Bank makes from selling waste. The questions are in the form of short entries at the applying cognitive level with the aspect of choosing a strategy (determining operations, strategies, and rules that are appropriate and efficient for solving real-world problems that can be solved using various methods). In question 2, the question format is a true/false complex multiple choice consisting of 4 statements with a cognitive level of knowing in the counting aspect, namely carrying out algorithmic procedures: addition, subtraction, multiplication, and division as well as their combinations. Question 3 is a complex multiple choice agreement/disagreement with the cognitive level of applying the interpreting aspect, namely by interpreting or providing an interpretation of problem-solving.

In stimulus 2, the mathematics questions developed were about "Classroom Equipment". The content used was algebra. It consists of 4 questions. The competency given is solving linear equations with two or three variables. Question 1 is in the form of multiple choice with the cognitive level Applying to the aspect of stating/making a model (modelling a problem in matrix form). Question 2 is in the form of a multiple choice cognitive level of knowing in the counting aspect. Question number 3 is a complex multiple choice with a cognitive level applying to choosing a strategy. Question 4 is a complex, true-false multiple choice with a cognitive level of reasoning in the concluding aspect (making valid conclusions based on information and facts).

Formative Evaluation Stage

At the formative evaluation stage, there are four research stages: self-evaluation stage, expert review, one-to-one stage, small group stage, and field test stage.

Self-evaluation stage

At this stage, the researcher evaluated the initial prototype that had been created at the preliminary stage based on the characteristics of AKM assisted by colleagues who work as mathematics teachers, and the result was prototype 1, which would be validated at the next stage, namely the expert review and one-to-one stage.

Expert Review and One-to-one stage

At the expert review stage, prototype one was validated regarding content, construct and language by three validators, namely 1) Rosuli (composer of the 2000 AKM numeracy questions and author of the SMA numeracy AKM Focus), 2) Fuad Hidayat (AKMI Instructor), 3) Aso Juharso (Mathematics teacher and head of the Adiwiyata curriculum). Comments, suggestions from experts and students, and revisions to question unit 1 and question unit 2 are presented in the following table.

Table 3. Comments/suggestions from experts and students on unit question 1

Validator	Comments/suggestions	Revision
Rosuli	Writing rupiah must comply with correct writing rules	The writing of the rupiah, originally followed by a period and a space, was changed to without a period and a space. The initial writing "Rp. 9,000.00" becomes "Rp 9,000.00"
Fuad Hidayat	The stimulus only informs about the Waste Bank. While the numeration is in the questions for which the new stimulus was created, please think again about creating the stimulus.	The primary stimulus is combined with the existing stimulus in question so that the primary stimulus contains information about the Waste Bank and its numerical information.
Student	Quite clear	-

Table 4. Comments/suggestions from experts and students on unit question 2

Validator	Comments/suggestions	Revision
Rosuli	The maximum number of questions in 1 stimulus is three; choose three from the four existing questions.	The initial number of questions of 4 was eliminated to become three questions.
Fuad Hidayat	The words '11 Mipa 2' do not comply with the rules for writing questions	The words '11 MIPA 2' were changed to '11 MIPA 2'
Student	The image on the stimulus is less clear	Unclear images are corrected to become clear.

Based on comments and suggestions from expert reviews and one-to-one results, prototype one was revised to become prototype 2, which will be tested at the next stage to test the practicality of the questions.

Small Group Stage

At this stage, the questions were tested on six students consisting of 3 class 10 students and 3 class 11 students with different abilities. These students are WRA, FFR, ILN, AM, RM and AHA. Based on the small group stage results, most students already understand the problems in the questions, form and instructions for the questions. One student still did not understand the meaning of the AKM question form, so the questions were revised by explaining the meaning in the instructions. This indicated that the student was unfamiliar with the AKM question form.

At the small group stage, apart from the questions, students were also given a questionnaire about the practicality of the questions, which were prepared with a score of 1 to 5 for each statement. The total score obtained from the questionnaire results equals 184, as seen in the following table.

Table 5. Practicality Questionnaire Results

Total Score	Interpretation
$48 + 115 \leq 185 < 48 + 153.6$	Good

The criteria for student responses to the practicality of the questions are in the "good" category. This shows that students' responses to the practicality of the questions were positive, meaning the questions were categorized as practical. In the small group stage, the questions were revised to produce a valid and practical prototype 3, Which was then tested at the field test stage to determine the potential effects of the questions. Below are prototypes of 3 units 1 and 2 in Figures 1 and 2.

Bank Sampah

Bank sampah merupakan konsep pengumpulan sampah yang dipilah serta memiliki manajemen layaknya. Perbedaannya melalui program menabung, namun yang ditabung bukanlah uang melainkan sampah. Bank sampah lebih menekankan fokusnya pada pengelolaan sampah yang merupakan permasalahan bagi lingkungan. Bank sampah merupakan salah satu solusi dalam mengatasi limbah yang berlebih dari kehidupan sehari-hari yang selanjutnya diolah menjadi sesuatu yang bernilai ekonomis. Sampah yang bisa ditabung adalah sampah yang bernilai ekonomi. Seperti sampah plastik, kertas, aluminium, besi, tembaga, perunggu, botol dll. Mekanismenya urut mengumpulkan dan menjual sampah kemudian sampah yang sudah terkumpul di serahkan ke Bank Sampah sekolah kemudian petugas Bank Sampah melakukan penimbangan terhadap sampah yang selanjutnya akan dikonversikan dengan nilai uang. Hasil konversinya dicatat dalam buku tabungan. Bank Sampah sendiri akan menjual kembali kumpulan sampahnya ke pihak pengepul sampah, berikut adalah harga beli sampah dari pengepul.

Daftar Harga Beli Sampah dari Pengepul Sampah

Jenis	Harga	Satuan
Plastik		
Gelas air mineral/ bening kotor	Rp2.300,00	Kg
Gelas air mineral/ bening bersih	Rp3.000,00	Kg
Botol air mineral/ bening kotor	Rp3.000,00	Kg
Botol air mineral/ bening bersih	Rp4.500,00	Kg
Botol warna	Rp1.800,00	Kg
Plastik emberan	Rp1.300,00	Kg
Gelas minuman warna	Rp1.300,00	Kg
Purikan	Rp2.000,00	Kg
Jergen mun. 5 liter warna putih susu	Rp2.000,00	Kg
Paralon	Rp500,00	Kg
Kertas Mika, dab	Rp500,00	Kg
Plastik bening	Rp1.000,00	Kg
Plastik campur kresek	Rp300,00	Kg
Campuran di luar botol, plastik PE, kardus dan kertas	Rp1.500,00	Kg

Sampah yang telah terkumpul akan dijual langsung ke pengepul, untuk itu harga yang di berikan ke nasabah harus ada selisih dengan harga dari pengepul tujuannya sebagai biaya operasional bank sampah sendiri. Namun ada juga sampah yang digunakan kembali dengan cara memanfaatkannya menjadi barang yang berguna dan bernilai ekonomi, seperti botol air mineral misalnya yang bisa digunakan untuk membuat *ecobrick*. Berikut adalah harga beli sampah dari pengepul sampah.

- Berdasarkan stimulus di atas, Sebagai sekolah perintis Adiwiyata, MA Mandiri akan mendirikan Bank sampah sekolah, di awal programnya yaitu bank sampah hanya akan menerima sampah anorganik dari nasabah. Bank sampah mengambil keuntungan 10% dari penjualan ke pengepul. Dalam setiap minggunya sampah yang terkumpul di bank sampah sekitar 50 kg sampah anorganik yang terdiri gelas air mineral bersih. Berapakah keuntungan dari bank sampah yang diperoleh dari penjualan sampah tersebut dalam waktu 3 bulan?
- Berdasarkan stimulus diatas, tentukan kebenaran pernyataan dibawah ini!

Pernyataan	Benar	Salah
Harga gelas air mineral bening bersih di bank sampah Rp2700,00/kg		
Harga kertas bekas di bank sampah Rp450,00/kg		
Selisih harga botol air mineral bening bersih dengan kotor mencapai 25%		
Harga plastik kresek di bank sampah Rp300,00		

- Berdasarkan stimulus di atas, tentukan pendapatmu setuju atau tidak setuju terhadap pernyataan berikut!

Pernyataan	Setuju	Tidak
Dengan selalu mengumpulkan plastik bekas bungkus makanan hingga 30 kg, mampu menambah sebanyak Rp9.000,00		
Menjual 3 kg gelas air mineral bening bersih menghasilkan uang Rp15.000,00		
Dengan mengumpulkan kertas yang sudah tidak terpakai sampai 10 kg bisa untuk menambah uang jajan Rp50.000,00		
Uang Rp10.000,00 bisa didapat dengan mengumpulkan 10 kg plastik bening bekas		

Figure 1. Prototype 3 units of question 1

Perlengkapan Kelas

Supaya kelas bisa digunakan dengan nyaman dan berfungsi secara optimal dibutuhkan beberapa perlengkapan kelas misalnya kebutuhan untuk kebersihan kelas, kebutuhan untuk perlengkapan pembelajaran, kebutuhan untuk tata ruang kelas dan.

Kelas 11 MIPA 2 berencana akan membeli beberapa perlengkapan kelas seperti sapu, kain pel, ember, kompor dan. Dengan menggunakan dana yang sudah terkumpul dari kegiatan nabung di bank sampah selama 1 semester.

Ada dua toko yang akan dikunjungi anak-anak 11 MIPA 2 yaitu toko Sederhana dan toko Maju Sejahtera. Berikut daftar harga yang ada di kedua toko tersebut.

Toko Maju Sejahtera
Daftar Harga

Paket 1 Rp. 10.000	Paket 2 Rp. 14.000	Paket 3 Rp. 17.000

TOKO SEDERHANA
DAFTAR HARGA

Paket Sederhana Rp. 12.000	Paket Sederhana Rp. 14.000	Paket Sederhana Rp. 16.000

- Berdasarkan harga tiap paket yang tersedia di toko maju sejahtera, harga sapu di toko tersebut adalah ...
A. Rp7.000,00
B. Rp8.000,00
C. Rp9.000,00
D. Rp10.000,00
E. Rp12.000,00
- ita mendapat titipan dari 1 kelas lain untuk membeli 3 alat kebersihan sapu, serek dan kain pel, sedangkan jumlah masing-masing alatnya diutamakan dengan kelas itu. Supaya belanja alat kebersihannya efisien, mana sajakah pilihan paket yang harus dibeli itu adalah ...
☐ paket 3 + paket sedang
☐ paket 1 + paket sedang
☐ paket 1 + paket 3
☐ paket 2 + paket biasa
☐ paket 3 + paket besar
- Berdasarkan paket alat kebersihan yang dijual di toko sederhana dan toko maju sejahtera, tentukan kebenaran pernyataan-pernyataan berikut.

Pernyataan	Benar	Salah
Harga sapu di toko sederhana lebih mahal dari toko maju sejahtera		
Harga serek di toko sederhana lebih mahal dari toko maju sejahtera		
Harga kain pel di toko maju sejahtera sama dengan di toko sederhana		
Selisih harga sapu di toko sederhana dengan di toko maju sejahtera Rp2000,00		

Figure 2. Prototype 3 units of question 2

Field test stage

At this stage, prototype three was tested on 26 students, consisting of 13th grade 10 and 13th grade 11. At this stage, all students took the test. The focus of this stage is to see the potential effect of the questions that have been developed on students' numeracy abilities.

Based on the results of students' work at the field test stage, it was found that 44.87% of the 156 (26×6) answer items analyzed were identified as correct answers. 44.23% of the 52 (26×2) subjects could solve the knowing-level questions. As many as 48.7% of 78 (26×3) subjects could solve questions at the Applying cognitive level, and 42.3% of 26 (26×1) subjects could solve questions at the cognitive reasoning level. This result further supports that students' numeracy abilities are low [7].

Unit question 1

This question unit 1 was developed to provide knowledge about the Waste Bank, one of the Adiwiyata programs in sustainable waste management (MAN 2 Tasikmalaya, 2020). In addition to activating numeracy skills, starting with basic mathematical skills, analyzing information from stimuli, and interpreting analysis results to make decisions, students are expected to know more deeply about handling inorganic waste and the benefits of managing waste. Unit question 1 consists of 3 questions. For the first question, 11 subjects were able to solve the questions correctly and were able to choose strategies for determining appropriate and efficient operations to solve real-world problems.

Handwritten student work for question 1:

$$\begin{aligned}
 & 50 \text{ kg (Aqua bersih 3000/kg)} \\
 & \text{minggu} \times 4 = 200/\text{bulan} \\
 & 3 \text{ bulan} \dots ? \\
 & 20 \\
 & 15.000/\text{minggu} \\
 & = 180.000 \text{ 3 bulan} \\
 & 50 \times 3000 = 150.000 \\
 & 150.000 - 10\% = 135.000 \\
 & 135.000 \times 4 = 540.000
 \end{aligned}$$

Figure 3. Student answers to question 1

Figure 3 is a student's strategy for solving problem 1. Based on the student's answers, it can be seen that students use various kinds of numbers and symbols related to basic mathematics to solve problems. This is the first indicator of numeracy ability, namely using various kinds of numbers and symbols related to basic mathematics to solve problems in various contexts of daily life.

Furthermore, for question number 2, as many as 23 subjects could not solve the problem correctly, and as many as ten subjects could not solve the problem correctly in question number 3, as can be seen in the answer of one of the ILN subjects below.

Figure 4. Answers to questions no. 2 & 3 in unit question 1

In Figure 4, the ILN subject could perform calculations correctly on question number 2. The subject could answer statements 1, 2 and 4 well, but on statement 3, he was wrong in determining the difference and could not use the right strategy to solve this question. Meanwhile, for question no. 3 ILN subjects were able to solve the questions well. This indicates that students are only able to fulfill some of the numeracy indicators in solving problems to the results of previous research, which states that students with very high, high and medium initial mathematics abilities are only able to fulfill some of the problem-solving indicators and numeracy indicators while students with low and very low, completely unable to meet the problem-solving indicators and numeracy ability indicators[17]

Unit question 2

Unit question 2 was developed to make students careful and efficient in doing things wisely in terms of numeracy, which aligns with the aim of environmental education, namely evaluating knowledge from an ecological, social and economic perspective [21].

In question 1, 20 subjects answered correctly, showing basic mathematical abilities at the knowing level. For question 2, 12 students could solve the question correctly at the Applying level; for question 3 at the reasoning level, only 11 students could answer the question well.

Figure 5. Subject N's answer to unit question 2

Figure 4 is the student's strategy for solving unit 2 questions. Based on the student's answers, it can be seen that students can translate the questions and model them well, then choose the right strategy to solve the questions. Subject N analyzes the problems in the questions

by identifying each price. Class equipment in each shop starts with determining the price of each equipment class in two stores and then comparing them. The results of the analysis are interpreted to make decisions. This shows that subject N has produced all the numeracy indicators well.

Apart from the test, students are also given a questionnaire to determine the potential effects of the questions, which are arranged with a score of 1 to 5 for each statement. The resulting total score is 547, so we get:

Table 6. Potential Effects Questionnaire Results

Total Score	Interpretation
$156 + 374.4 \leq 547 < 156 + 499.2$	Good

Based on the table above, it can be seen that the results of the questionnaire responses to the potential effects of student numeracy are in the excellent category. This shows that the students responded positively to the questions being developed. Students feel interested, challenged and motivated to solve the problems.

CONCLUSION

This research produced 30 Adiwiyata-based mathematics questions that were valid and practical and had potential effects using the development studies research type through 2 stages, namely preliminary and formative evaluation.

At the preliminary stage, learning in the classroom must be integrated with environmental education or Adiwiyata, including making questions. The characteristics of AKM questions are content, context and cognitive level (AKM Framework analysis). The final activity at this preliminary stage is designing questions. The result of this preliminary stage is an initial prototype.

The formative evaluation stage consists of 3 stages (self-evaluation, expert review and one-to-one, small group and field test). The initial prototype was evaluated independently at the self-evaluation stage. The result was prototype 1, which experts reviewed based on content, construction and language at the expert review stage. Simultaneously with the expert review stage, prototype one was given to 3 students with different abilities to obtain clarity and readability of questions at the one-to-one stage. Comments and suggestions from experts and students were used as the basis for revisions, which resulted in prototype 2, which consisted of 30 mathematics questions based on AKM in the Adiwiyata context. Prototype 2 was tested on six students to obtain data about the practicality of the questions at the small group stage and obtain a response in the "good" category. Student comments on the questionnaire sheet and test results were used to revise prototype 2 to become prototype three. Tested in 26 classes, six students felt 'excited' even though it was challenging to do the questions. Four students felt happy working on AKM-based questions because they were not fixated on formulas, six were interested in the AKM questions, and three felt challenged to solve AKM questions.

Students' numeracy skills are still low in solving AKM-based mathematics problems. According to the research data, only 44.87% of the 156 (26 students x 6 questions) analyzed answer items were identified as correct. Supported by analyzing student comments on the questionnaire, students still find it difficult to answer questions.

The hope for teachers is to use context-based questions in learning so that students get used to solving AKM-type questions. It is hoped that future researchers can develop mathematical questions in other contexts as references for AKM questions, which are currently very limited. It is hoped that it can also provide alternative learning solutions to overcome students' low numeracy abilities.

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