Hipotenusa : Journal of Mathematical Society
Volume 6 Issue 2 Year 2024
ISSN: 2716-3156
Website: https://ejournal.uinsalatiga.ac.id/index.php/hipotenusa/index

Analysis of Mathematical Connection Ability Through Project Asesmen Sumatif Akhir Jenjang (ASAJ) in Junior High School

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DOI: 10.18326/hipotenusa.v6i2.2197

Article submitted: July 19, 2024
Article reviewed: November 30, 2024
Article published: December 30, 2024

Abstract

This study aims to assess students' ability to link mathematical concepts with recycling projects through the implementation of an end-of-level summative assessment (ASAJ). The recycling project was chosen as the final assessment to enrich students' experience through direct application to real-world situations. This type of research is descriptive with a qualitative approach. The subjects in this study were four groups selected based on the criteria determined by the researcher. The data collection techniques used were documentation in the form of student reports and interviews with teachers and students. This assessment is the final assessment of project-based ninth grade students with the theme of 3R (reuse, reduce, recycle). The results showed that students can process used goods or waste that is difficult to decompose into goods that have selling value. In addition, the implementation of this assessment shows that students are not only able to identify and apply mathematical patterns and concepts in this project but also use mathematical calculations and data to make relevant decisions during the project process. This ability can be seen in how students connect mathematical theories with practical contexts such as scale calculations and social arithmetic. This research is expected to be an illustration for schools or teachers who want to implement project-based learning and assessment in addition to providing a more contextual and applicable learning experience, especially for the surrounding environment.

Keywords: asaj, mathematical connection ability, project 3r

INTRODUCTION

Asesmen sumatif akhir jenjang (ASAJ) was conducted in March-May 2023. In general, asesmen sumatif akhir jenjang (ASAJ) for ninth grade uses objective tests such as multiple choice. Still, the school has agreed with the supervisor to carry out a project-based end-of-level summative assessment with the theme 3R (Reuse, Reduce, Recycle). Based on the interviews, the school has not linked the ASAJ to the current independent curriculum. However, the reason the school chose the project as the final assessment was the result of a review of government regulations in the city of Bandung regarding the

assessment of students in the 2022/2023 academic year in the context of post-pandemic learning recovery. Therefore, the school decided for ninth grade to carry out asesmen sumatif akhir jenjang (ASAJ) through a project where students create a work following a theme determined by the school and then students carry out an open hearing by presenting the work made in three languages (English, Indonesian and Sundanese).

A study showed that the impact of implementing mathematics projects showed aspirational project quality, improved student learning outcomes in mathematics learning, and sustainability related to projects for future life. (Pentang, 2021). The use of problem-based project learning generally shows the benefits of collaboration, artifacts, technology, problem-centeredness, and scientific practices such as research, presenting results, and reflection. (Markula & Aksela, 2022). In addition, project-based learning shows a positive contribution to student motivation, learning, and teamwork in implementation which is in line with the development of 21st-century skills. (Viro E, 2020). The application of project-based learning not only fulfills learning objectives but more than that, students are required to actively take part in planning, implementing, and implementing the work that has been made. So, most schools began to implement project-based learning to improve student skills and make math learning more meaningful.

However, there are some challenges, especially for teachers, in planning and assessing project-based learning where careful consideration is needed so that project implementation is not perfunctory. Considerations in assessing a project, especially in science and math projects where the nature of project work is diverse, the need for objective and criteria-based assessment, and the limitations of common assessment methods used. This is a concern because the resulting project grades can be biased, unlike objective assessments in general. As Haines (1991) Points out, that the use of specific methods to combine scores on different aspects of a project does not significantly affect the overall score, so a scoring system with categorization is a more realistic option than assigning scores numerically. The assessment suggested by the University of Chicago School Mathematics Project in the USA is a knowledge assessment for various topics based on 4 dimensions including Skills (S) that deal with procedures and algorithms Properties (P) that address fundamental concepts, Uses (U) that emphasize application-focused, Representations (R) about schematics, images, or other visual aids for conceptual understanding. (Suurtamm et al., 2016). Project assessment, especially in mathematics, can be comprehensive following the intended learning objectives and the assessment results are not biased.

ASAJ is carried out for two months, starting with planning, implementing activities, and evaluating and following up. The implementation of this final assessment covered all subjects, where each teacher determined achievement indicators, daily journals, and assessment rubrics according to the subjects taught. This research focuses on the application of mathematics, which is implementing mathematics material with projects that students make, including scale/comparison and social arithmetic. With the basic competencies taken on scale/comparison material related to solving problems related to the ratio of two quantities. The basic competencies in social arithmetic material are solving problems related to social arithmetic (addition, purchase, deduction, profit, loss, single interest, percentage, gross, net, tare). Thus, this assessment project in addition to

following the theme set by the school regarding the 3Rs (Reuse, Reduce, Recycle), subject teachers, especially mathematics, formulate indicators including 1) interpreting the results of the ratio of two quantities in real problems, 2) solving problems related to sales prices, purchases, profits and losses and 3) making projects in designing types of household businesses with small capital.

For students themselves, processing used goods is important to encourage students' concern for the environment. Research conducted by Nizaar et al. (2020) Also shows that waste management training with the 3R principle (Reduce, Reuse, Recycle) has a significant positive effect on increasing students' environmental awareness. Quoted from the Pilapitiya & Ratnayake (2024) Article, 3R waste management training includes activities such as sorting organic and inorganic waste, making organic fertilizer, and making handicrafts from used materials. Plastic's adaptable qualities have made it a necessary material for human existence, but because it degrades slowly in the environment, plastic trash has become a global issue. Plastic waste can break down into micro and nanoscale particles, which can have detrimental effects on aquatic and terrestrial ecosystems as well as human health. To control the production of plastic trash and encourage sustainable practices, numerous laws and policies have been adopted at the international, regional, and national levels. So, the recycling project into a work carried out at school is a good breakthrough because the impact is not only on the environment, but this project can also improve students' ability to connect and hone students' creativity so that used goods can become new works with selling power.

Students' mathematical abilities that can be measured include problem solving, connection, communication, reasoning, and representation. When students connect mathematical ideas, their understanding will be deeper and more enduring, and they will see mathematics as a coherent whole. They see mathematical connections in the rich interactions among mathematical topics, contexts that connect mathematics to other subjects, and their interests and experiences. Through teaching that emphasizes the interconnectedness of mathematical ideas, students learn mathematics and the usefulness of mathematics (NCTM, 2000). In the literature, there is a significant focus on connections targeted at using cultural activities to understand school mathematics. Contexts are helpful to the extent that they provide access to school mathematics. However, students' ability to make connections within mathematics is critical for conceptual understanding (Anthony & Walshaw, 2009) and applications beyond the discipline (Madusise & Mwakapenda, 2014). This view regards mathematics as relevant and practical. Mathematics has utility value and can be applied to everyday life. From this orientation, teachers play an important role; they should train students to investigate mathematics and be 'models' and 'conveyors' of school mathematical knowledge (Graven & Venkat, 2007). Therefore, teachers should teach lessons to enable students to recognize and understand these mathematical connections.

Most researchers and teachers still associate mathematical connection skills with other mathematical abilities. As with the research conducted by Pambudi et al. (2020) Which links mathematical connections with problem solving, mathematical connections themselves are an important tool that students can use to solve mathematical problems. This is evident when the results show students who have strong mathematical connection

skills are more successful in solving math problems. In addition, further research investigates students' mathematical connection skills through a realistic mathematics approach where the results show that the students studied meet the 4 indicators of connection skills through the problems given. (Wagino & Andriani, 2021). In addition, another similar study related to the application of the project-based learning (PjBL) model which is associated with mathematical connection skills through giving questions where the results showed that there was a positive effect of the PjBL model on the mathematical connections of grade IV students (Kafah et al., 2024). Some studies have not specifically linked connection skills with the real world, especially in waste recycling projects. This research offers a new approach to exploring mathematical connection skills, especially in the waste recycling process, which has not been widely applied in the context of mathematics education in secondary schools.

This project-based assessment is expected to improve students' knowledge and skills as well as improve students' mathematical connection ability. Addin et al. (2014) explain that project-based learning can involve active students by practicing their abilities and knowledge in producing a product. Moreover, project-based learning can improve students' mathematical connection skills (Kenedi & Nelliarti, 2019). Indicators of mathematical connection skills include 1) recognizing and using relationships among mathematical ideas; 2) understanding how mathematical ideas are interconnected and build on each other to produce a coherent whole; 3) recognizing and applying mathematics in contexts outside of mathematics (NCTM, 2000). Based on the description from NCTM, it can be concluded that the indicators used in this study are connections between mathematics, connections with other disciplines, and connections with the real world or with everyday life. The positive findings above encouraged the researcher to look in detail at the use of assessment in project-based mathematics learning associated with mathematical connections. This study provides findings in mathematics learning that show that project-based assessment, especially recycling projects can be an effective strategy for improving students' mathematical connection skills. The purpose of this study is to analyze the mathematical connection ability in asesmen sumatif akhir jenjang (ASAJ) of grade IX junior high school.

METHODS

This research was conducted in one of the public junior high schools in Bandung City with the research subjects being ninth grade students in the 2022/2023 school year. Furthermore, the systematic approach and procedures used in the research will be explained, including research design, subject selection, data collection techniques, data analysis procedures, and ethical considerations applied to ensure the validity and integrity of the research results.

Research design

The type of research used was descriptive research with a qualitative approach. The researcher was carried out to describe the mathematical connection ability of students during the implementation of the project-shaped end-of-level summative assessment. The characteristics of qualitative research include 1) the natural environment, 2) the researcher

as a key instrument, 3) data sources used interviews, observations, documentation, and audiovisual information, 4) the research process is always developing dynamically 5) researchers reflect on how their role in developing the meaning they perceive as a source of data, 6) a holistic view. (Creswell, 2019). The data collected from the assessment report results were visualized using tables and figures to provide a clear picture of students' mathematical connection skills in the assessment process. It is then examined in depth to understand the extent to which students can integrate mathematical concepts in this assessment project.

Subject

The subjects of this study were 4 groups, and each group consisted of 5-6 people who were selected based on criteria determined by the researcher. The subject selection criteria include 1) ninth grade students in the 2022/2023 school year, 2) have completed all stages of the summative assessment, and 3) research subjects were selected based on availability and accessibility criteria, namely students who can still be contacted and are willing to participate in interviews to support data collection relevant to the research objectives. The object of this research is to the application of mathematics in the 3R project made by students and then analyze the mathematical connectionist ability of students in the implementation of mathematics in the project that has been made.

Data Collection

Data collection techniques include interviews with teachers and students, interviews using semistructured methods, where in the process using interview guidelines but more flexible so that researchers can ask questions outside the interview guidelines but must not get out of the topic under study. Furthermore, documentation in the form of ASAJ operational procedures, student reports, and student assessment results.

Data Analysis

The data analysis of this research consists of 1) data reduction, this research focuses on the implementation of mathematics in projects that students and the results of interviews have made; 2) data presentation, student answers included in scientific paper reports and interview results from the results of data reduction, and 3) conclusion drawing, carried out by assessing the achievement of indicators of students' mathematical connection skills between solving mathematical problems and projects that have been made. To identify mathematical connection ability, the following rubric assesses mathematical connection ability.

Table 1. Rubric of Mathematical Connection Ability

No	Aspect	Indicator
1	Relationships between math topics	Students can determine the appropriate math topic between the predetermined indicators and the 3R project. Students can elaborate on the appropriate math topics between the predetermined indicators and the 3R project. Students can connect the appropriate math topics between the predetermined indicators and the 3Rs project.

No	Aspect	Indicator
2	Relationship with other disciplines	Students can apply the 3Rs project linked to other disciplines
3	Connection with the natural world	Students can relate the math content of the 3Rs project to real-world situations.

Modified from NCTM (2000)

The three aspects above will be analyzed based on students' reports. Then, the researcher will analyze whether the 3R project students have carried out has fulfilled the three aspects of mathematical connection ability. Then, interview guidelines will be shown to teachers and students so that they can complete the research data, as shown in Table 2.

Table 2. Interview Guidelines

Aspects	Indicator
1. Preparation for ASAJ implementation	a) Teacher's role in ASAJ preparation b) Students' needs before the implementation of ASAJ
2. ASAJ Implementation	a) Overview of the ASAJ process b) The benefits of implementing ASAJ for students c) Teachers' strategies in achieving the success of ASAJ
3. Evaluation of ASAJ implementation	a) Successful implementation of ASAJ b) Obstacles to the implementation of ASAJ c) Efforts to overcome ASAJ obstacles

Modified from Rohmatilah (2022)

Ethical Studies

This study pays strict attention to ethical aspects to protect participants, including the following; 1) Informed consent where the researcher provides thorough information regarding the objectives, procedures, and benefits before the subject agrees as a participant, 2) Research subjects have the freedom to withdraw at any time without consequences, 3) The researcher ensures that the interview atmosphere is comfortable and if the participant feels disturbed, the interview can be temporarily stopped.

RESULTS AND DISCUSSION

Implementing asesmen sumatif akhir jenjang (ASAJ) for three weeks has shown positive results for students and teachers. In addition to this ASAJ, as the final assessment carried out in ninth grade, it is also something that can have a good impact on every element that takes part and the surrounding environment. Project-based assessment is not new in education; project-based learning has been used in the 2013 curriculum to enable students to carry out exploration, assessment, interpretation, synthesis, and information to produce various learning outcomes (Lismarika, 2021). However, it is still rare for teachers to implement project-based learning models. As Dewi (2023) explained, the implementation requires sufficient preparation and takes a long time.

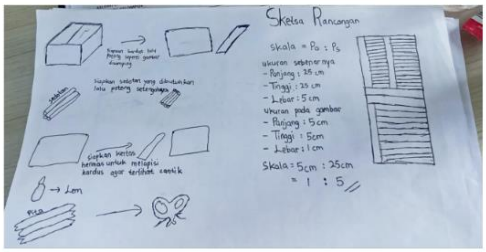
From the results of interviews with supervising teachers, the project-based assessment shows that students are very enthusiastic about doing projects. In addition to

the assignment factor that will affect the final assessment in grade IX, many new things are obtained by students, including processing used goods into new goods that can generate profits. Students are also trained in writing scientific papers in the form of reports, and students are trained to communicate in open hearings to present the work made from recycled materials. The following are some of the results of student work in recycling used goods, the application of mathematics in projects carried out, and the analysis results based on indicators of mathematical connection ability.

Utilization of Polypropylene Plastic Waste into TEMALIS

Plastic straws that are only used once result in the accumulation of plastic straw waste and become one of the elements that cause environmental damage because they are not easily decomposed materials. According to Agustian S et al. (2020), plastic straws contained in polypropylene and polystyrene are drinking aids whose use is only for a moment and ultimately increases the amount of existing waste. Many socializations have been made to reduce plastic straw waste, including in schools, by processing it into learning media.

In this ASAJ implementation, one group of 6 people processed plastic straw waste into valuable items by making stationery holders that had artistic value and were marketable. The application of mathematics to this stationery holder is the calculation of scale, where the design sketch's length, height, and width are compared to the actual size, as shown in Figure 1. In addition, students show the profit from the capital spent with the specified selling price of the goods.



Sketsa Rancangan :

SKALA = PG : PS

Ukuran Sebenarnya	**Ukuran pada gambar**	Skala = 5 cm : 25 cm
- Panjang = 25 cm	Panjang = 5 cm	**= 1 : 5**
- Tinggi = 25 cm	- Tinggi = 5 cm	
- Lebar = 5 cm	= Lebar = 1 cm	

TABEL PENGELUARAN

Hari/tanggal	Keterangan	Pemasukan	Pengeluaran	Saldo
Senin 1 Mei 2023	sedotan	Rp.27.000	-	Rp.12.000
	Kertas metalik	-	Rp.5.000	-
	Lem	-	Rp.10.000	-
	Kardus	-	-	-

HARGA JUAL

Harga jual = Rp.40.000 – Rp.50.000

Modal = Rp. 30.000

Dana per-orang (Rp.6.000)

Sketch of the design:

Scale = PG : PS

Actual Size	**Size in the picture**	**Scale**
Long = 25 cm	Long = 5 cm	5 cm : 25 cm
Height = 25 cm	Height = 5 cm	= 1 : 5
Width = 5 cm	Width = 1 cm	

TABLE OF FUNDS EXPENDITURE

Date	Information	Income	Outcome	Total
Monday, May 1, 2023	Straw	Rp27.000	-	Rp12.000
	Metallic paper	-	Rp5.000	-
	Glue	-	Rp10.000	-
	Box	-	-	-

Selling Price

Selling price = Rp40.000-Rp50.000

Working Capital = Rp30.000

Funds per person = Rp6.000

Figure 1. Scale and Calculation Price of TEMALIS

G : How was your experience working on this ASAJ project?

S1 : Our experience in working on this project was quite fun, although at first we were confused about connecting mathematical concepts with this waste recycling project. However, after discussions with friends and teachers, we tried to determine the size so that it could be calculated and scaled.

G : How did you connect the mathematical concepts during this project?

S1 : because the designs we make form blocks so we can determine the scale size based on the picture and the actual size. Then we were also told to determine the selling price of the item.

G : What are the benefits of your project in everyday life?

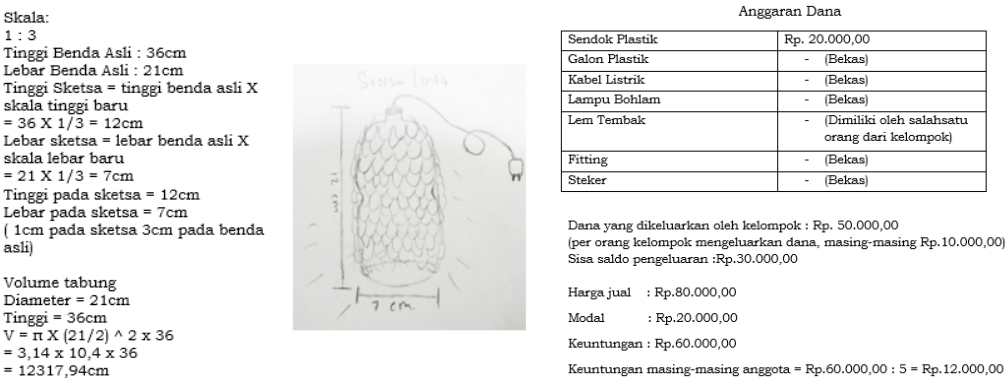
S1 : We can use this to store stationery

The results of the analysis related to the processing of plastic spoons into stationery holders associated with mathematical connection skills have fulfilled all three aspects. This can be seen when students can determine the scale of the pencil case in the picture and the actual pencil case resulting from the straw recycling process and the selling price of the pencil case based on the capital that has been spent. So, the group fulfilled the first aspect of mathematical connection skills related to the relationship between mathematical topics. Furthermore, the group has linked to other disciplines such as how to protect the surrounding environment by processing plastic waste that is difficult to decompose into objects that have a selling value. And other aspects, the group has linked to the real world where this stationery holder can be used daily by students to carry stationery that is often lost or scattered.

Processing Waste into LENTICS

The following waste processing is plastic spoon waste processing. A group of 5 people manage organic waste from plastic spoons into scales lanterns (LENTIK), as shown in Figure 2. Plastic spoons are also a waste that is difficult to decompose. However, there are already those who utilize plastic spoon waste, which is intended to complement the interior, one of which is in research conducted by Nabila (2017), showing that the waste can be applied to jewelry products and different fashion products.

In addition to plastic spoons, of course, several items are used as a complement to the decorative lamp. The unique thing is that these students use used items to complement the capital spent small while the selling value can be very high. Like other groups, students determine the scale value by comparing the height and width in the picture with the actual height and width of the scales lantern. In addition, from the results of the group interview, which the mentor teacher also accompanied, they took the initiative to calculate the volume because the lamp was in the form of a tube, so in addition to determining the scale and selling price, the students determined the volume of the tube.



Skala:
1 : 3
Tinggi Benda Asli : 36cm
Lebar Benda Asli : 21cm
Tinggi Sketsa = tinggi benda asli X skala tinggi baru
= 36 X 1/3 = 12cm
Lebar sketsa = lebar benda asli X skala lebar baru
= 21 X 1/3 = 7cm
Tinggi pada sketsa = 12cm
Lebar pada sketsa = 7cm
(1cm pada sketsa 3cm pada benda asli)

Volume tabung
Diameter = 21cm
Tinggi = 36cm
V = π X (21/2) ^ 2 x 36
= 3,14 x 10,4 x 36
= 12317,94cm

Anggaran Dana

Sendok Plastik	Rp. 20.000,00
Galon Plastik	- (Bekas)
Kabel Listrik	- (Bekas)
Lampu Bohlam	- (Bekas)
Lem Tembak	- (Dimiliki oleh salahsatu orang dari kelompok)
Fitting	- (Bekas)
Steker	- (Bekas)

Dana yang dikeluarkan oleh kelompok : Rp. 50.000,00
(per orang kelompok mengeluarkan dana, masing-masing Rp.10.000,00)
Sisa saldo pengeluaran :Rp.30.000,00

Harga jual : Rp.80.000,00
Modal : Rp.20.000,00
Keuntungan : Rp.60.000,00
Keuntungan masing-masing anggota = Rp.60.000,00 : 5 = Rp.12.000,00

Scale	= 1:3
Real height	= 36 cm
Real width	= 21 cm
Sketch height = real height x scale	$= \frac{1}{3} = 12m$
Sketch width = real width x scale	$= 21\ \frac{1}{3} 7\ cm$

Tube Volume

$V = \pi r^2 t$
$= 3{,}14\ x\ (\frac{21}{2})^2\ x\ 3$ = 12317, 9 cm

TABLE OF FUNDS EXPENDITURE

Plastic spoons	Rp20.000
Plastic gallon	- (ex)
Power Cable	- (ex)
Light Bulb	- (ex)
Glue	- (ex)
Fitting	- (ex)
Sticker	- (ex)

Funds spent	: Rp50.000
Selling price	: RP80.000
Working Capital	: Rp20.000
Profit	: Rp60.000
Profit gain	: Rp12.000

Figure 2. Scale and Calculation Price of LENTIK

G : What are the benefits of your project in everyday life?

S2 : can be used to light up the room miss

G : How did you connect the mathematical concepts during this project?

S2 : determine the size of the design drawings that we made before this project so the lights then determine the actual size to determine the scale. In addition, determine the selling price because this is very interesting and has a selling power.

G : How did this project help you with maths problems in everyday life?

S2 : We can find the scale of items in everyday life and can determine the selling price value of profit and capital spent.

Based on the results of the analysis of student reports, show that the processing of plastic spoons made into decorative lamps has fulfilled the three aspects of mathematical connection skills, including the group being able to determine the topic of scale and the selling price by describing the budget as capital and can minimize expenses by using other used items, besides that it has been able to connect with mathematical topics outside those determined by the teacher regarding the volume of the tube. Furthermore, the group has applied this decorative lamp product to protect the environment by processing plastic spoon waste which is difficult to decompose. This shows that the LENTIK recycling project has been linked to other disciplines, namely science related to protecting the environment. In addition, the group has been able to relate to the real-world context where this decorative lamp is very useful for use in the dark or at night even though it still

requires electricity. This shows that students have fulfilled all three aspects of mathematical connection ability.

Processing Bottle Cap Waste into KETUPAT

In the interview, one of the students said that we can change this calendar to the current month because the calendar is intended not only for one month but can be used in the following months and years. Based on the results of experiments conducted by Hendrawan & Najib (2019), plastic bottle waste that is heated using an iron visually produces a texture like leather texture; therefore, the results of the experimental process have the potential to be developed into fashion accessories products in the form of handbags. Turning bottle cap waste into a calendar is called ketupat craft. The measurements done by this group include the calculation of scale in calculating the length and width in the image compared to the actual length and width. In addition, the profit in the sale of this ketupat calendar has been adjusted to the capital and selling price determined as in the picture.

- TABEL PENGELUARAN

NO	NAMA ALAT DAN BAHAN	PENGELUARAN
1.	GUNTING	-
2.	CUTTER	-
3.	PENGGARIS	-
4.	PENSIL	-
5.	BASKOM	-
6.	SARUNG TANGAN PLASTIK	-
7.	STRAPLES	-
8.	KANVAS 40 x 60	Rp. 21.000,-
9.	TUTUP BOTOL	-
10.	DUPLEX	Rp. 8.800,-
11.	CAT AIR	-
12.	KUAS	-
13.	KERTAS KORAN	-
14.	LEM	Rp. 7.500,-
15.	SPIDOL PERMANENT	-
16.	KARDUS	-
17.	ANTSEPTIK	-
18.	TISSUE/LAP KAIN	-
19.	AIR	-
20.	BUNGA KERING	Rp. 11.000,-
	TOTAL	Rp. 48.300,-

Setelah melakukan diskusi yang mendalam tentang berbagai aspek, termasuk harga, kreativitas, dan jasa pembuatan, kami telah menetapkan harga sebesar **89.000** untuk kerajinan **KETUPAT** ini. Dan jika **KETUPAT** ini terjual, kami akan memperoleh keuntungan sebesar **40.700** yang akan dibagi rata kepada 5 para pembuat karya **KETUPAT** ini sebesar **8.140**.

Sketch: Real

p = 3 cm : p = 60 cm

l = 2 cm : l = 40 cm

Scale for long

Sketch long: Real long

3 : 60

1 : 20

Scale for width

Sketch width: Real width

2 : 40

1 : 20

TABLE OF FUNDS EXPENDITURE

No	Tools and Material	Outcome
1	Scissors	-
2	Cutter	-
3	Ruler	-
4	Pencil	-
5	Basin	-
6	Plastic gloves	-
7	Straples	-
8	Canvas 40 x 60cm	Rp 21.000
9	Bottle cap	-
10	Duplex	Rp 8.000
11	Cat air	-
12	Paintbrush	-
13	Newspaper	-
14	Glue	Rp 7.500
15	Permanent Marker	-
16	Box	-
17	Antiseptic	-
18	Tissue	-
19	Water	-
20	Plastic flower	Rp 11.000
	Total	Rp 48.300

After an in-depth discussion on various aspects, including price, creativity, and manufacturing services, we have set a price of Rp89.000 for this KETUPAT craft. If this KETUPAT is sold, we will get a profit of Rp40.700 which will be divided equally among the 5 KETUPAT makers by Rp8.140.

Figure 3. Scale and Calculation Price of KETUPAT

G : What are the benefits of your project in everyday life?

S3 : can turn used bottle caps into calendars that can be used daily

G : How did you connect the mathematical concepts during this project?

S3 : According to the teacher's direction calculate the scale of the calendar and calculate the profit earned with the predetermined selling price.

G : How did this project help you with maths problems in everyday life?

S3 : I can calculate the scale and determine the selling price bu from processing used goods made into this calendar

The results of the student report show that the artistic bottle cap calendar (KETUPAT) has fulfilled all three aspects of mathematical connection. This is shown by the student's ability to connect between topics following predetermined indicators related to determining the overall scale value of the project that has been made and can describe expenses in tabular form to be able to determine higher selling power. Furthermore, the group has been able to apply other disciplines, namely the history of calendars ranging from functions to the form of calendars used to date. With this, students are not only focused on recycling bottle caps but have been able to connect with historical material. In addition, the group has also linked to the real-world context where it is described in the report that the use of calendars in the business world shows the breadth of the connection of this bottle cap recycling project with the real world.

Utilization of Waste Cans into KOMBES

The group of five people designed a stove that was recycled from used cans. The cans are made of heavy metals such as potassium and magnesium, so they cannot be decomposed, and used cans are one of the objects that can pollute the environment (Busyairi et al., 2018). There are three types of cans used for experiments with different sizes; from the three cans, there is a scale measurement that compares the actual diameter of the can and the diameter of the can in the picture and measures the ratio between the actual height of the can and the height of the can in the picture (in this case the can is tubular) as shown in Figure 4 and the application of arithmetic regarding the selling price and profit is shown in Figure 5.

G : How was your experience working on this ASAJ project:

S4 : I'm happy miss, we often get together to make KOMBES, even though it's hard to gather the kids. I also make reports and presentations, and even though I've done it many times, I'm nervous because it's for the final grade.

G : How did you connect the mathematical concepts during this project?

S4 : we are assisted by our teacher to determine the capital to make the project and what the expenses are. Then, we decided on the selling price, which was agreed together because of calculated the expenses so that we could make a profit. So, the maths concept is about selling price and calculating scale too.

G : What are the benefits of your project in everyday life?

S4 : can be used for cooking, we have tried to cook eggs and noodles.

- **SKALA**

1. Kaleng minuman dengan tinggi 11,5 cm dan diameter 6 cm

Skala diameter kaleng minuman :

diameter sebenarnya ÷ diameter gambar : 6 ÷ 5 = 1,2 cm

skala = 1 : 5

Skala tinggi kaleng :

Tinggi sebenarnya ÷ tinggi kaleng : 11,5 ÷ 5 = 2,3 cm

Skala = 1 : 5

- **DESAIN KARYA**

Drink cans with a height of 11.5 cm and a diameter of 6 cm

Drink cans diameter scale

real diameter : sketch diameter = 6 : 5 = 1,2 cm

Scale = 1 : 5

Can height scale

Real height : Sketch height = 11,5 : 5 = 2,3 cm

Scale = 1 : 5

Figure 4. Scales of KOMBES

- **TABEL PEMASUKKAN DAN PENGELUARAN**

No	Barang	Pemasukkan	Pengeluaran	Saldo
1	Kaleng minuman	Rp 35.000	Rp 0	-
2	Kaleng makanan (tango)	-	Rp 0	-
3	Kaleng makanan (astor)	-	Rp 0	-
4	Mesin pompa air galon + sedotan stainless	-	Rp 0 (karena bekas)	
5	Bensin	-	Rp 4.500	Rp 30.500
6	2 selang kecil	-	Rp 2.000	Rp 28.500
7	Cat spray hitam	-	Rp 28.500	0
8	Paku	-	Rp 0	
9	Palu	-	Rp 0	
10	Lem tembak dan isinya	-	Rp 0	
	Total	0	Rp 35.000	0

- **HARGA JUAL**

Harga jual : Rp 70.000

Modal/pengeluaran : Rp 35.000

Dana per orang (totalnya ada 5 orang) : Rp 7.000

Keuntungan per orang :

- Rp 70.000 – Rp 35.000 = Rp 35.000
- Rp 35.000 ÷ 5 = Rp 7.000

TABLE OF FUNDS EXPENDITURE

No	Stuff	Income	Outcome	Total
1	Drink cans	Rp 35.000	Rp 0	
2	Food cans (tango)	-	Rp 0	
3	Food cans (astor)	-	Rp 0	
4	Water pump gallon	-	Rp 0 (ex)	
5	Fuel	-	Rp 4.500	Rp 30.500
6	2 small hose	-	Rp 2.000	Rp 28.500
7	Cat spray	-	Rp 28.500	
8	Nail	-	Rp 0	
9	Hammer	-	Rp 0	
10	Glue	-	Rp 0	
	Total	0	Rp 35.000	0

Selling Price

Selling Price	= Rp 70.000
Working Capital	= Rp 35.000
Independent income	= Rp 7.000
Profit gain	= Rp 70.000 – Rp 35.000 = Rp 35.000: 5 = Rp 7.000

Figure 5. Calculation Price of KOMBES

Based on the analysis of the reports that students have done, students already have mathematical connection skills by fulfilling the three aspects of mathematical connection. This group has been able to determine the mathematical topic following the indicators determined by the teacher, which is related to the scale and selling price of the project that has been made. However, in determining the scale, students only showed one of the three cans measured which of the three cans had different sizes. Furthermore, the group has been able to connect with other science disciplines such as fuel use, evaporation, and air dispersion. This shows that students have fulfilled the aspects of mathematical connections related to other disciplines. In the third aspect, the group has linked to the real-world context where the cans processed into stoves have been tested by cooking eggs and noodles using kombes.

Overall, each group was able to link the recycling project with mathematical connections. This can be shown by several characteristics including; 1) Generally students are able to find and explain mathematical patterns or relationships in the recycling process, such as calculating recyclable materials, comparing sizes or volumes, and calculating the efficiency of using materials, 2) The application of mathematical concepts to the project demonstrated such as measurement and calculation to design or repair recyclables such as scale measurement, 3) Students have been able to relate the recycling project to relevant mathematical situations or problems, such as calculating costs, optimizing the use of materials, or estimating the number of items that can be recycled, 4) In addition, students have been able to relate the project to other mathematical concepts which students can relate the recycling project to other relevant mathematical concepts, such as scale and social arithmetic and explain how these concepts are applied in the context of their project, and 5) Students have been able to formulate a mathematical relationship between the recycling project and other mathematical concepts, And 6) Students were able to formulate mathematical problems related to the recycling project and solve them using mathematical methods, demonstrating their understanding of how mathematics can be applied in real-world situations.

ANALYSIS OF ASAJ RESULTS

There are three approaches to learning assessment: assessment of learning, assessment for learning, and assessment as learning (Earl, 2006). In the ASAJ project, teachers used all three assessment approaches from planning, implementation, and final evaluation at the open trial. The assessment is carried out during the open session so that the assessment or assessment becomes biased because it is seen from planning to project presentation. However, subject teachers can see from their point of view according to the indicators to be achieved. Especially in mathematics, the assessment focuses on scale/comparison and social arithmetic. According to the teacher's explanation, the assessment in mathematics includes starting from ideas, sketches, or drawings of products with scale, reports, and student presentation results. The following is the percentage of grade IX students' math scores in each aspect.

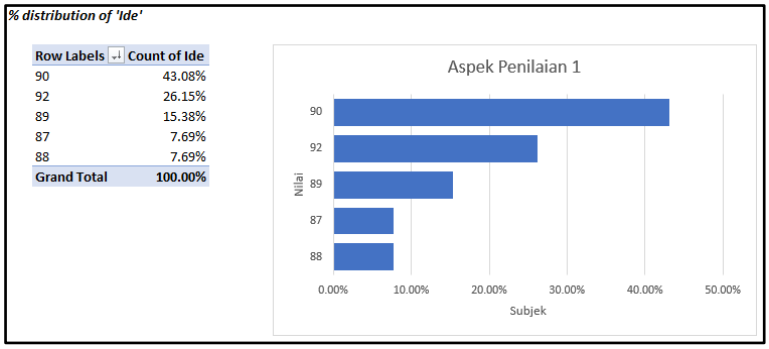


Figure 6. Mathematical Score on Idea Aspect

In the first assessment aspect, as shown in Figure 6 regarding the ideas conveyed by students related to the project to be made, it shows that 26.15% got a score of 92, and 43% reached a score of 90, meaning that in group discussions, students have been able to convey ideas related to the project to be made by adjusting the ASAJ theme, namely the 3Rs (Reuse, Reduce, Recycle). Students have been able to analyze the mathematical measurements that will be used to make the project. The other 31% scored less than 90, where students were able to determine the mathematical measurements used in the project but did not explain the mathematical calculations in detail. This aspect of the assessment is included in the assessment for learning, where the assessment takes place to diagnose students' needs. The mentor can also design the following steps as scaffolding to improve the quality of their work in making the 3R project (Stiggins *et al.*, 2007).

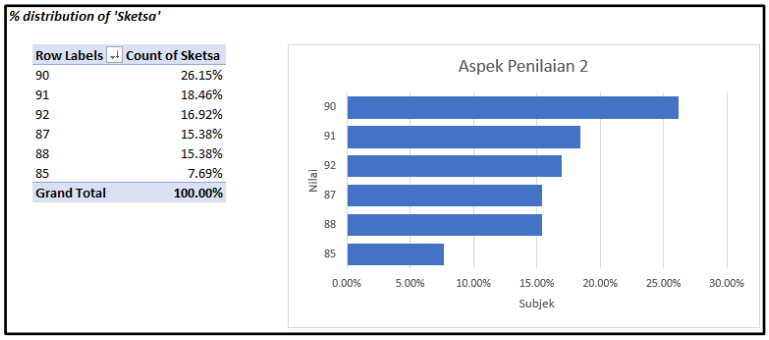


Figure 7. Mathematical Score on Sketch Aspect

The next aspect concerns the sketch or product image adjusted to the learning objectives determined regarding scale material. Figure 7 shows that as many as 61.53% of students have achieved a score of more than 90, meaning that students can use scale material in the projects. While 38.47% of other students scored 85 - 87, students can determine the value of the scale, but there are still some mistakes, namely in the calculation operation. Doing this project has a positive impact because students can implement the material on concrete objects using the scale material learned in theory in seventh grade. Yılmaz et al. (2010) identified that factors that include real life, classroom activities, and the use of learning materials connected to mathematics can improve mathematics skills in providing explanations of the concepts taught. So, in implementing ASAJ, students understand that learning mathematics is closely related to everyday life.

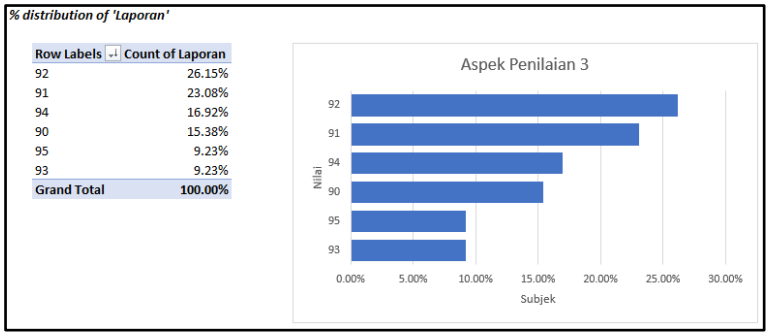


Figure 8. Mathematical Score on Report

Figure 8 shows the aspect related to the report, which is an assessment of learning, where all students have produced a 3R project by presenting it in a report as a scientific paper. This aspect assesses the overall use of mathematics such as scale and selling price presented with a detailed table so that students are not just original in determining the selling price but have been calculated starting from the capital spent and the profit earned. In addition, some groups have been able to present other materials, such as using the volume of space in the project that has been made.

Of all the ASAJ processes that have been carried out, there will always be obstacles. The following obstacles occurred as a whole during ASAJ: 1) mastery of tools and materials, 2) systematic preparation of paper reports, 3) student obstacles when the work process does not match their expectations, so students often feel disappointed, but scaffolding carried out by the supervisor of each group can build student characteristics and students are motivated to make their projects to the maximum and 4) external factors because it is the only school that implements project-based final assessment.

Beyond all the obstacles, some benefits can be taken including for students 1) students can work together in teams, 2) increase creativity in honing (soft skills and hard skills), understanding of concepts and student analysis power, 3) the first experience for students in conducting open trials and 4) fostering a sense of responsibility and active collaboration. The benefits for teachers include 1) differentiated learning, where teachers better understand the strengths and weaknesses of students. 2) as a barometer of how teaching to students should be, and 3) teachers begin to learn to spark creativity from hidden students. The benefits for schools include 1) discussions between the school and the supervisor in elaborating changes in regulations so that it becomes the only school that carries out project-based final assessments and 2) support from the education office, which provides positive appreciation, motivates students to continue working and continue schooling to the highest level.

CONCLUSION

Based on the student work that has been completed and analyzed according to the indicator of the student's mathematics connectivity, it can be concluded that the students have, overall, demonstrated a significant level of proficiency in connecting mathematical concepts to real-world applications through the project of a bekas bottle. Every group successfully identifies and applies concepts, laws, and mathematical pressure to manage and assess the project in question. This ability can also help them sharpen their

understanding of mathematics and how that discipline's applications might be used to solve actual-world problems. In this way, the integration of asesmen sumatif akhir jenjang (ASAJ) has proven to be effective in strengthening students' mathematical connections and enhancing their learning experiences with relevant and useful contexts. This research can be an illustration for educators and other students in learning and project-based assessment not only in mathematics but other fields of science that can be applied in schools.

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