

PAPER • OPEN ACCESS

Student's mathematical literacy: *case study in an implementation of PISA type problem-based worksheet context of statistics data of Lampung province*

To cite this article: W Widyastuti and A P Wijaya 2020 *J. Phys.: Conf. Ser.* **1467** 012075

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

Student's mathematical literacy: case study in an implementation of PISA type problem-based worksheet context of statistics data of Lampung province

W Widyastuti¹, A P Wijaya¹

¹Department of Mathematics and Science Education, Lampung University, Prof. Dr. Ir. Soemantri Brojonegoro street number 1, Lampung, Indonesia

***widyastuti.1986@fkip.unila.ac.id**

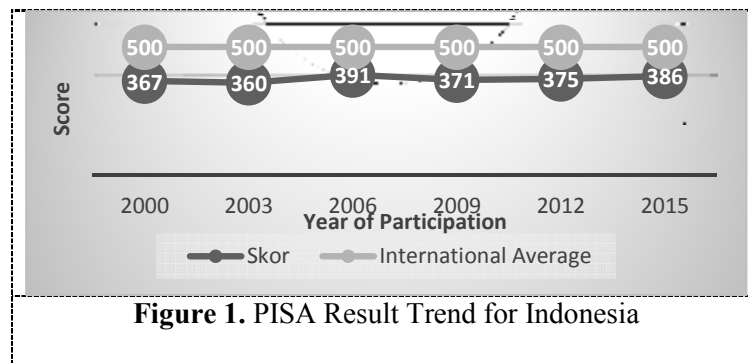
Abstract. This research aimed to describe student's mathematical literacy in an implementation of Programme for International Students Assessment (PISA) type problem-based worksheet context of statistics data of Lampung Province. This research was conducted on 18 junior high school students of SMPN 21 Bandar Lampung and 18 junior high school students of SMPN 9 Bandarlampung in academic year 2019/2020. The respondents were chosen randomly which has high, medium, and low mathematical ability. Data were collected using test of mathematical literacy which adopted from PISA 2015 measurement. Data analyzed using Wilcoxon test in 5% significance level. Based on research result, it was concluded that there is a significant difference between student's final mathematical literacy and student's initial mathematical literacy abilities his conclusion indicated that implementation of PISA type problem-based worksheet context of statistics data of Lampung province affected student's mathematical literacy ability.

1. Introduction

Assessing mathematical literacy become one of PISA concern in providing the comparisons in student performance. PISA stands for the Program for International Student Assessment, which has been started by the Organization for Economic Cooperation and Development (OECD) or economic cooperation and development organizations, to evaluate the education system of 72 countries around the world. [1] Mathematical literacy defined as an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena [2]. this ability to engage with science (science) on related problems and with science ideas as a reflection of citizens[3] and This ability assists students to recognise the mathematics contribution in the world.

Indonesia has been participated in PISA measurement since 2000. Based on OECD, PISA result for Indonesia since 2000 until 2015 shown in Figure 1.





Based on Figure 1, Indonesia score increases for three last measurement. It means that the evidence of 9-year compulsory education achievements and expansion towards a 12-year fair and the inclusion of Indonesian student participation in education paid off [11]. However, the improvement still above the international average which implies, continues improvement in the quality of education in Indonesia is still needed to develop student's mathematical literacy. Mathematical literacy is regarded as valuable outcomes of schooling, then they should be well represented in intended and implemented curricula [4].

Good literacy ability is needed to understand mathematics with or without numbers. mathematics is the science that discusses numbers and calculations, discusses numerical problems, concerning numbers and quantities, studies the relationships of patterns, shapes and structures, means of thinking, collections of systems, structures and tools. Science Literacy is the ability to engage with science (science) on related problems and with science ideas [3-5]. The key to all literacy were reading, the ability to understand spoken words and decode the written words, up to an in-depth understanding of the text [8]. This suggests the need to facilitate students in each learning activity with these abilities. Many researchers develop student's literacy abilities. Some of them, develop the package of test item which is related to the use of mathematics in social life, for example in Maduran ethnic culture [9]. Another researcher try to analyse the test instrument that develop by teacher in junior high school in Way Kanan [10]. Those researches relate to the measurement of student's performance. However, mathematical literacy ability also can be developed inside the classroom activities.

Teacher can develop student's mathematical literacy through learning activities. learning activities help students understand concepts precisely which are useful for solving various problems in life using concepts they understand and and make learning effective and efficient. [9 - 10] so the need for media In learning activities, media play an important role. learning media will help students in understanding the material and the use of media adapted to the characteristics of the material being taught and the characteristics of students. [10 - 11-12] Media in mathematics learning consist of print and non-print media. Worksheet is one of printed media which can be constructed by teacher. Worksheets are a learning tool that can be used by teachers in increasing the involvement or activities of students in the learning process, [16-17] Worksheets that are developed by teachers should refer to student's mathematical literacy abilities. Moreover, mathematics as one subject in national curricula is related to "real life" problems. This means that the problem in mathematics should arises in a situation. Wisconsin states on its website that to teach mathematical literacy, curriculum and teaching should include: a) relevant mathematical concepts, principals and procedural, b) life contexts that can be investigated and mathematically modelled, c) rich in tasks mathematics that fosters conceptual understanding and development of thinking skills and habits [8].

Familiarization with questions of PISA type also needs to be given in mathematics learning activities. These process of familiarization mathematical literacy are not enough by giving students ordinary mathematics problems, which brings consequence for teacher to construct mathematical literacy problems[18]. De Lange states that "students need to experience solving mathematics problems in different situations and contexts to develop their ability to transfer their knowledge from

one area of application to another" [19]. This means, an implementation of PISA type problem-based worksheet is needed. PISA problems are characterized by context. One of context that could be used in the development of PISA type problem-based worksheet is uncertainty and data content related to statistics. Statistics of Lampung province is government agencies that provide data for government policies both local and central government. Data from Statistics of Lampung province based on real situation of country living. By using Statistics data of Lampung province, can give real life problem to students and could facilitated students to become good citizen.

Solving problems in PISA type problem-based worksheet requires the ability to formulate problems in mathematical form. It also guides students to employ the mathematics facts/procedures. Solving these problems being expected could affect students' mathematical literacy abilities. so that research is conducted aimed at describing the mathematical literacy abilities of students after implementation of PISA type problem-based worksheet context of Statistics data of Lampung province.

2. Method

This research was quantitative research to describe student's mathematical literacy ability. The respondent of this research is 18 junior high school students of SMPN 21 Bandar Lampung and 18 junior high school students of SMPN 9 Bandar Lampung in academic year 2019/2020 which were chosen randomly and represent high, medium, and low mathematical ability. Data collected using test of mathematical literacy which adopted from PISA 2015 measurement. This research used the following design:

$$O_1 \quad X \quad O_2$$

O_1 = pre-test of mathematical literacy

O_2 = post-test of mathematical literacy

X = research treatment by implementing PISA type problem-based worksheet context of statistics data of Lampung province

After pre-test and post-test data were collected, data were grouped using ideal criterion calculation based on ideal mean and ideal standard deviation, using formula in Rachmat and Solehudin [20] which is

$$\bar{x}_{ideal} + z \cdot s_{ideal}$$

x_{ideal} = the maximum score possible by students

$$\bar{x}_{ideal} = \text{ideal mean} = \frac{1}{2} \cdot x_{ideal}$$

$$s_{ideal} = \text{ideal standard deviation} = \frac{1}{3} \cdot \bar{x}_{ideal}$$

z = standard score

Based on that formula, the categories presented were made and shown in Table 1.

Table 1. Interpretation of Gain Score

Gain	Interpretation
$x < 75.005$	Very High
$58.335 < x \leq 75.005$	High
$41.665 < x \leq 58.335$	Moderate
$24.995 < x \leq 41.665$	Low
$g < 24.995$	Very Low

Calculating the normalized gain score, using the formula $N\text{-gain } (g) = (\text{posttest} - \text{pretest}) / (\text{maximum ideal score} - \text{pretest})$ [9]. The N-gain calculation results were then interpreted using the classification on Table 2 below

Table 2. Interpretation of N-Gain Score

N-Gain	Interpretation
$(g) \geq 0.7$	High
$0.3 \leq (g) < 0.7$	Moderate
$(g) < 0.3$	Low

After, the N-gain scores were calculated, then data were analysed descriptively and inferentially using Wilcoxon test in 5% significant level.

3. Result and Discussion

3.1 Research Result

Data about student's mathematical literacy abilities were obtained through mathematical literacy tests. The test is given twice, namely before (pre-test) and after (post-test) the implementation of Worksheet in learning settings. After obtaining the initial data and the final data of mathematical literacy ability of students, then the normalized gain score calculation was performed. The recapitulation of students' mathematical literacy abilities generally is illustrated in Table 3.

Table 3. Recapitulation of Student's Mathematical Literacy Based on Grade Level

	Minimum Score	Maximum Score	Mean	Standard Deviation
<i>Pretest</i>	16.67	75.00	50.56	17.42
<i>Posttest</i>	16.67	88.89	60.23	18.80
<i>N-Gain</i>	-0.25	0.69	0.20	0.24

Based on Table 3, the maximum score and the average score of student's mathematical literacy ability after the implementation of the PISA type problem-based Worksheet is greater than the maximum score and the average score of student's mathematical literacy ability after to the implementation of PISA type problem-based worksheet. This indicates the positive impact of treatment on student's mathematical literacy ability. However, the average n-gain score of a student's mathematical literacy ability which less than 0.3 indicates a low categorized improvement. On the other hands, the minimum score for n-gain of mathematical literacy ability = -0.25 indicates that there are students who have decreased mathematical literacy scores as a result of the implementation of PISA type problem-based worksheet. If it was reviewed from the grade level, the recapitulation of student's mathematical literacy shown in Table 4.

Table 4. Recapitulation of Student's Mathematical Literacy Based on Grade Level

Grade	Minimum Score	Maximum Score	Mean	Standard Deviation
VII <i>Pretest</i>	16.67	72.22	41.67	19.17
<i>Posttest</i>	16.67	88.89	46.53	23.57
<i>N-Gain</i>	-0.25	0.69	0.11	0.26

	Grade	Minimum Score	Maximum Score	Mean	Standard Deviation
VIII	<i>Pretest</i>	37.50	65.00	49.58	12.38
	<i>Posttest</i>	55.00	77.50	64.17	5.67
	<i>N-Gain</i>	-0.20	0.44	0.25	0.23
IX	<i>Pretest</i>	25.00	75.00	60.42	15.84
	<i>Posttest</i>	42.50	87.50	70.00	14.54
	<i>N-Gain</i>	0.00	0.67	0.24	0.21

Based on Table 4, it was known that an increase occurred in student's mathematical literacy abilities in all grade level. The average n-gain score in the three groups of students less than 0.3 which indicated that the increase occurred in the low category. The minimum scores for n-gain of students in all three groups were negative and also zero. It indicated that there were students who have not experienced an increase in mathematical literacy abilities.

The potential effect of the implementation of PISA type problem-based worksheet were calculated using the average difference between the initial scores and final scores of students which was tested using Wilcoxon test in 5% significant level. The result of Wilcoxon test using SPSS 22 is shown in Figure 1 below

Null Hypothesis	Test	Sig.	Decision
1 The median of differences between Pretest_literasi and Posttest_literasi equals 0.	Related-Samples Wilcoxon Signed Rank Test	,000	Reject the null hypothesis
Asymptotic significances are displayed. The significance level is ,05.			

Figure 2. Hypothesis Test Summary for Wilcoxon Test

Based on Figure 2, the conclusion of the test at 5% significance level was rejected the null hypothesis. This means that there were differences in student's final mathematical literacy abilities and student's initial mathematical literacy abilities.

3.2 Discussion

Research result in this study noted that before the implementation of PISA type problem-based worksheet, the mean score of student's mathematical abilities was 50.56 with the minimum score of 16.67 and the maximum score of 75.00. This indicates that the research respondents have the initial mathematical literacy abilities in medium category. However, there were students with very low category in mathematical literacy abilities and there were also students with high category of mathematical literacy abilities.

After the implementation of PISA type problem-based worksheet context of Statistics data of Lampung province, it is known that the mean score of student's mathematical literacy ability is 60.23 with a minimum score of 16.67 and a maximum score of 88.89. This indicates that the research respondents have the final mathematical literacy in the high category. However, there are students with very low categorized mathematical literacy abilities and there are also students with very high categorized mathematical literacy abilities. This condition also tells us that the implementation of PISA type problem-based worksheet context of Statistics data of Lampung province affected the student's mathematical literacy ability.

It is also shown that there were differences in student's final mathematical literacy abilities and student's initial mathematical literacy abilities which indicates the effect of the implementation of PISA type problem-based worksheet context of Statistics data of Lampung province. This is because, when students work together in solving the problem in the worksheet, there were involved in the processes that relate to formulating real world problems in mathematical terms so that they can be solved as mathematical problems. Then, students also involved in the processes of employed the mathematics procedure and interpreted mathematical solution to provide an answer of the real-world problem. In the formulation stage, the problem solver faces a problem situated in a real context, and then gradually trims away aspects of reality, recognising underlying mathematical relations, and describes the problem in mathematical terms [4].

Based on the analysis of the normalized gain score, the implementation of PISA type problem-based worksheet context of Statistics data of Lampung province made the mean n-gain score of student's mathematical literacy ability is 0.20 which in the low category. The mean n-gain score for every grade level also less than 0.3 which means that the improvement of student's mathematical literacy for students in each grade level still in low category. It indicates that continual familiarization is still needed. Teacher can develop PISA type problem-based worksheet in other context that relate to real life problems.

Based on the observation in the learning process, it is known that the moral content of mathematical concepts is conveyed well through worksheets that describe the real facts. Using PISA type problem-based worksheet make students actively involved in the learning process. The benefits and meaningfulness of mathematics are also more visible in the learning process that used PISA type problem-based worksheet context of Statistics data of Lampung province.

The familiarization of PISA type problems in mathematical learning is expected to improve students' mathematical literacy abilities and have implications for increasing the acquisition of Indonesian scores in international measurements. Wu showed how countries' national performance is affected by the alignment of its curriculum with the PISA assessment [4]. Mathematics literacy is required to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens [2] and also has a significant relationship with students' critical thinking [10].

4. Conclusion

Based on research result and data analysis, we draw the following two conclusions. First, student's improvement in mathematical literacy are considered in low level. In other word, mathematics subject should give more concern to the problems that develop mathematical literacy ability. Second, there is a significant difference between student's final mathematical literacy and student's initial mathematical literacy abilities. This finding indicates that the implementation of PISA type problem-based worksheet context of Statistics data of Lampung Province affected the student's mathematical literacy ability.

Reference

- [1] L. Listiana, A. Abdurrahman, A. Suyatna, and P. Nuangchalerm 2019 The Effect of Newtonian Dynamics STEM-Integrated Learning Strategy to Increase Scientific Literacy of Senior High School Students *J. Ilm. Pendidik. Fis. Al-Biruni* **8** 1 . 43–52
- [2] OECD 2013 PISA 2015 DRAFT MATHEMATICS FRAMEWORK 2013.
- [3] A. Asyhari 2017 Literasi Sains Berbasis Nilai-Nilai Islam Dan Budaya Development Of Physics Learning Devices Based On Critical Thinking Skills In Problem-Based Learning **06** 137–148
- [4] K. Stacey 2011 The PISA View of Mathematical Literacy in Indonesia **2** 2 95–126
- [5] A. Thahir, A. Mawarni, and R. Palupi 2019 The effectiveness of demonstration methods assisting multiplication board tools for understanding mathematical concept in Bandar Lampung, *J. Educ. Gift. Young Sci* **7** 2 353–362
- [6] R. B. B. J. Rose 2000 Writing and mathematics instruction *spinger*.
- [7] K. Raghubar, M. A. Barnes, and Steven A. Hecht 2010 Working memory and mathematics: A

- review of developmental, individual difference, and cognitive approaches *J. Learn. Individ. Differ.*, **20**, 2 110–122.
- [8] Syahlan 2015 Literasi Matematika dalam Kurikulum 2013 *J. Penelitian, Pemikir. Dan Pengabd.* **3** 1 36–43, 2015.
- [9] S. Saukiyah, Sunardi, and Trapsilasiwi Dinawati Pengembangan Soal Literasi Matematika Berbasis Budaya Etnik Madura Untuk Siswa Smp/Mts
- [10] Budiono 2012 Analisis instrumen asesmen berbasis literasi matematika di smp 542–549, 2012.
- [11] H. Putranta and Supahar 2019 Development of physics-tier tests (PysTT) to measure students' conceptual understanding and creative thinking skills: A qualitative synthesis *J. Educ. Gift. Young Sci* **7** 3 747–775.
- [12] R. A. Pratama and A. Saregar 2019 Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Scaffolding Untuk Melatih Pemahaman Konsep *Indones. J. Sci. Math. Educ.* **2** 184–97
- [13] H. Yuliani 2017 Pembelajaran Fisika Menggunakan Media Animasi Macromedia Flash-Mx dan Gambar Physics Learning Using Macromedia Flash-Mx Animation Media And Picture to Improve Students ' Concepts *J. Ilm. Pendidik. Fis. Al-BiRuNi* **6** 1 13–21
- [14] A. Novianto and N. Diana 2019 Penerapan Program Crocodile Physics Sebagai Media Pembelajaran dalam Upaya Meningkatkan Pemahaman Konsep Fisika Siswa,” *Indones. J. Sci. Math. Educ* **2** 11–8
- [15] A. Asyhari and H. Silvia 2016 Pengembangan Media Pembelajaran Berupa Buletin dalam Bentuk Buku Saku untuk Pembelajaran IPA Terpadu *J. Ilm. Pendidik. Fis. Al-Biruni* **5**, 1,
- [16] C. T. Noprinda and S. M. Soleh 2019 Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Higher Order Thinking Skill (HOTS) *Indones. J. Sci. Math. Educ* **2** 2 168–176,
- [17] I. Nurhayati, A. D. Yusandika, S. Basyar, and Y. Anjelinar 2019 Pengaruh Model Pembelajaran Novick Berbantuan LKPD Terhadap Kemampuan Kognitif Peserta Didik *Indones. J. Sci. Math. Educ* **2** 3 353–362
- [18] P. N. Malasari, T. Herman, and A. Jupri 2017 The Construction of Mathematical Literacy Problems for Geometry *J. Phys. Conf. Ser* **895** 1
- [19] M. M. Simalango and N. Aisyah 2018 Kesulitan Siswa Dalam Menyelesaikan Soal-Soal Pisa Pada Konten Change And Relationship Level 4 , 5 , Dan 6 Di SMP N 1 Indralaya **12** 1 43–58,
- [20] Widyastuti 2010 Pengaruh Pembelajaran Model-Eliciting Activities Terhadap Kemampuan Representasi Matematis Dan Self-Efficacy Siswa

Acknowledgments

We would like to thank to Lampung University, mathematics education lecturers, four mathematics teacher as experts, and 36 students of grade VII, VIII, and IX at two of state junior high school, for their participant.