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DAPIC Problem-solving Process Towards Elementary Students' Statistical Literacy

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ABSTRAK

Literasi statistik merupakan salah satu jenis literasi yang menekankan pada kemampuan membaca, menginterpretasikan, memahami, mengomunikasikan, dan menganalisis data informasi secara kritis pada abad saat ini. Kemampuan literasi statistik siswa bagi sekolah dasar dipandang belum mencukupi. Penyebabnya yaitu terbatasnya proses pemecahan masalah pada materi literasi statistik. Penelitian ini untuk memberikan solusi permasalahan mengenai literasi statistik siswa sekolah dasar dengan menggunakan proses pemecahan masalah DAPIC (Define, Assess, Plan, Implement, and Communicate). Metode eksperimen dengan pretest-posttest control group design digunakan pada 38 siswa sekolah dasar. Instrumen yang digunakan adalah tes literasi statistik yang dianalisis menggunakan rumus Aiken V. Hasil penelitian memberikan rata-rata nilai N-Gain berada pada kategori sedang yaitu kurang dari sama dengan 0.3-0.7. Uji Wilcoxon menunjukkan nilai 0.002, sehingga terdapat perbedaan rata-rata antara kedua kelas. Dengan demikian, proses pemecahan masalah DAPIC memberi dampak positif pada literasi statistik siswa sekolah dasar.

ABSTRACT

Statistical literacy emphasizes the ability to read, interpret, understand, communicate, and critically analyze information data in the current century. Students' statistical literacy skills in elementary schools are considered insufficient. The reason is the limited problem-solving process on statistical literacy material. This research is to solve problems regarding elementary school students' statistical literacy by using the DAPIC problem-solving process (Define, Assess, Plan, Implement, and Communicate). An experimental method with pretest-posttest control group design was used on 38 elementary school students. The instrument used was a statistical literacy test analyzed using the Aiken V formula. The results of the study provided an average N-Gain value in the moderate category, which is less than equal to 0.3-0.7. The Wilcoxon test shows a value of 0.002, so there is an average difference between the two classes. Thus, the DAPIC problem-solving process positively impacts elementary school students' statistical literacy.

1. INTRODUCTION

Statistical literacy emphasizes reading, interpreting, understanding, communicating, and analyzing information data critically (Kurnia et al., 2023; Masfingatin & Suprapto, 2020; Ziegler & Garfield, 2018). Statistical literacy has advantages over other types of literacy, namely as a need for every individual to be able to be literate in information and is the result of learning activities in schools (Hafiyusholeh et al., 2018; Hariyanti & Wutsqa, 2020; Hassan et al., 2020). Statistical literacy, as one of the learnings in schools today, requires students to have the ability to understand and evaluate data critically (Koparan, 2015; Nahdi et al., 2021; Wallman, 1993). The Ministry of Education and Culture of the Republic of Indonesia has started a program introducing literacy in elementary school education units to prepare human resources for the 21st century (Hariyanti & Wutsqa, 2020; Setiawan, 2019). In the current century, statistical literacy must be taught to elementary school students regarding data used in everyday life (Fadillah & Munandar, 2021; Guven et al., 2021). Statistical literacy encourages students to have the ability to comprehend and apply the statistical principles they have learned. Students must solve statistical problems and have a purposeful sense of statistical concepts (Sabbag et al., 2018; Wahab et al.,

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2018). In this case, teachers need to provide statistical literacy knowledge to students since they are in the early grades because it is a foundation for understanding the data provided (Hariyanti & Wutsqa, 2020; Sharma, 2017). Understanding data requires essential competencies. These important competencies are that students must understand statistical principles, have insights related to applications, have numeracy skills and graphing skills, have data interpretation skills, and have skills in visualizing and communicating data (Ezra Putranda Setiawan, 2021; Tiro, 2018). The expectations above do not match the reality on the ground. The fact in the field shows that students consider most statistical concepts complicated and challenging to understand (Johannis Takaria & Melvie Talakua, 2018; Mandap, 2016). Students' success in achieving PISA scores that remain stable from year to year raises the assumption that the statistical literacy skills taught in elementary schools are insufficient (Purwadi, 2021; Setiawan, 2019). Another study showed that 80% of students had difficulty analyzing data because they could not understand statistical concepts (Nurdianti et al., 2022; Purwati et al., 2022).

Meanwhile, statistical literacy has not been a significant concern in the national literacy movement for elementary schools in Indonesia. The lack of ability to read, process, and present data that fall into the low category is the leading cause of this problem (English, 2018; Setiawan, 2019; Wahab et al., 2018). Elementary school students need statistical literacy so that they have a higher level of data understanding and are better able to act intelligently with quantitative data in the surrounding environment, as well as being able to read, interpret, and draw conclusions from a number of existing data (Abidin et al., 2020; Utomo, 2021). Students with difficulty understanding statistical literacy can be resolved by choosing the proper problem-solving process (Emilia & Amir, 2022; Fadillah & Munandar, 2021). The right problem-solving process for students is the DAPIC problem-solving process (CeMaST et al., 1998; Meier et al., 1996; Trianawaty Anwar et al., 2018; Wulandari et al., 2020). The DAPIC problem-solving process has five elements, namely Define (D) identifying problems related to student experience; Assess (A) assessing the problem situation and collecting information obtained, Plan (P) planning problem-solving, Implement (I) implementing the plans that have been made, and Communicate (C) presenting the results analyzed and evaluating them (Meier et al., 1996; Paramita et al., 2019; Risnanosanti & Ristontowi, 2019). The DAPIC problem-solving process is closely related to students' daily lives. This can provide opportunities for students to understand concepts that start from observing a problem, analyzing by linking the information obtained into an appropriate solution strategy, and determining the proper steps for problem-solving (Abdulah et al., 2022; Sumirattana et al., 2017).
The five DAPIC problem-solving process elements can facilitate students' understanding of statistical literacy (Risnanosanti & Ristontowi, 2019; Trianawaty Anwar et al., 2018). The DAPIC problem-solving process can be used inside and outside the classroom, can improve students' critical thinking skills, and can increase students' self-confidence (Abdulah et al., 2022; Wulandari et al., 2020). The DAPIC problem-solving process positively impacts students' critical thinking skills so that students can solve statistical literacy problems in their daily lives (Paramita et al., 2019; Wulandari et al., 2020). Previous researchers used the DAPIC problem-solving process for junior high school students (Abdulah et al., 2022; Risnanosanti & Ristontowi, 2019; Rohayati et al., 2020; Sumirattana et al., 2017; Trianawaty Anwar et al., 2018; Wulandari et al., 2020). One of them is using the DAPIC problem-solving process for eighth-grade students on mathematical literacy materials (Risnanosanti & Ristontowi, 2019). The results showed that learning using the DAPIC problem-solving process gave good results in mathematical literacy (Risnanosanti & Ristontowi, 2019). In addition to providing good results in mathematical literacy, the DAPIC problem-solving process can also improve critical thinking skills and increase self-confidence in seventh and ninth-grade students (Masjaya et al., 2022; Sumirattana et al., 2017; Trianawaty Anwar et al., 2018). Based on the empirical studies above, the DAPIC problem-solving process is only used with junior high school students. No research pertaining to the DAPIC problem-solving process for statistical literacy in elementary school pupils has been found. A study is required to examine the DAPIC problem-solving process's effect on elementary school students' statistical literacy to cover the gap in research results based on the above studies. This study aims to ascertain how the DAPIC problem-solving procedure influences the statistical literacy of students in elementary schools.

2. METHOD

This study employs experimentally-based quantitative research methods. The experimental method employed was a control group design comprising a pre-and post-test. The study's design was adapted from (Sugiyono, 2013), shown in Figure 1.

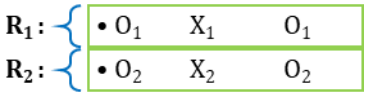
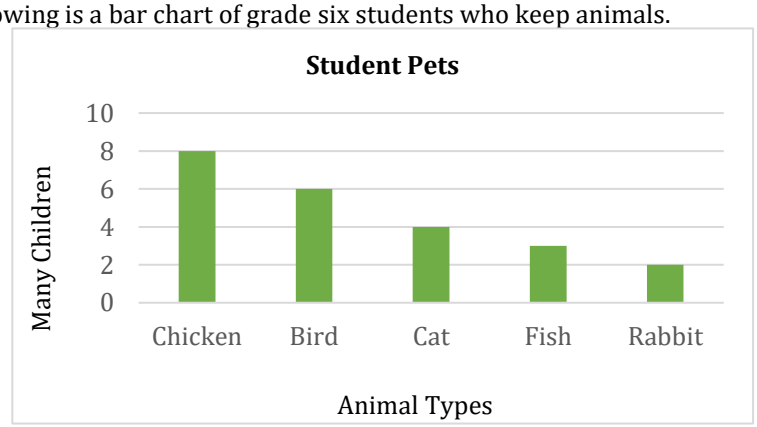


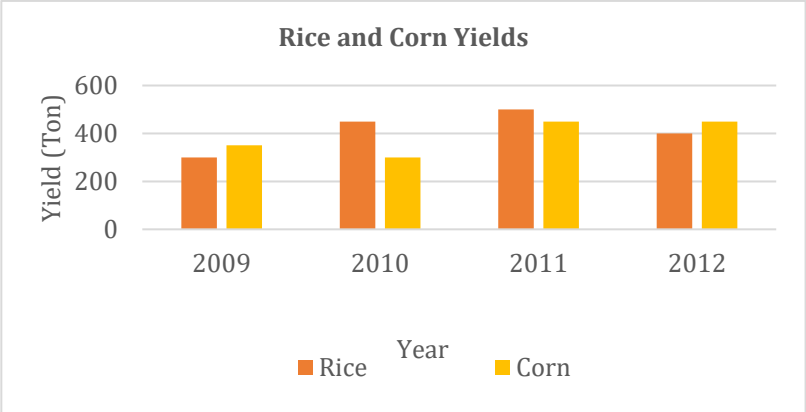
Figure 1. Pretest-posttest Control Group Design Chart

Description:
R1: Experimental class
R2: Control class
O1: Initial proficiency test
X1: Treatment using the DAPIC problem-solving process
X2: Treatment using problem-based learning
O2: Final proficiency test

The design chart in **Figure 1** illustrates two groups randomly selected to determine the control group and experimental group and then given a pretest-posttest at the beginning to determine if there is a difference between the two groups (Sugiyono, 2013). The subjects in this study were six-grade students of SDN Candinegoro (one of the elementary schools in Sidoarjo Regency, East Java Province). Of 38 sixth-grade students who were randomly divided into experimental and control groups, 19 students became the experimental group, which will follow mathematics learning using the DAPIC problem-solving process. The other 19 students became the control group, which will follow mathematics learning using problem-based learning (PBL). Interpretation and analysis of statistical data were covered in both classes. At the beginning and end of learning, students were given a test to ascertain their level of statistical literacy. The data collection technique used a statistical literacy test. In this case, the research instrument is a statistical literacy test consisting of three essay questions. The three essay items on the statistical literacy test are presented in Table 1.

Table 1. Statistical Literacy Test

Item Number	Problems
1	The following is a bar chart of grade six students who keep animals.  Select more than one answer for each of the following statements based on the bar charts mentioned above. ▪ The animal that students keep the least is fish. ▪ Eight students keep chickens. ▪ The difference between students who keep birds and rabbits is 4. ▪ The most common animal kept by students is the cat.
2	Consider the following data on the Math test scores of 39 sixth-grade students. 70 70 65 85 75 90 80 65 70 80 90 75 70 80 85 90 70 85 75 75 85 80 85 65 75 80 90 75 80 90 70 5 75 80 90 75 75 70 90 Based on the information above, choose more than one answer that corresponds to the following statements. ▪ Three students scored 65. ▪ The mode of the Math test score data is 75. ▪ The median of the Math test score data is 75. ▪ The average or mean value of the Math test score data is 90.

Item Number	Problems
3	The yields of rice and corn in Candinegoro Village for four years are presented in the following diagram.  Select more than one answer for each of the following statements based on the bar charts mentioned above. ▪ Rice yields in 2010 were higher than those in 2011. ▪ The difference between rice and maize yields in 2009 and 2012 is 200 tons. ▪ Maize yields have been decreasing every year. ▪ The total maize harvest in 2009-2012 was 1550 tons.

The statistical literacy test refers to indicators that include the ability to read data, calculate data ratios, and extract information. The statistical literacy test results were scored using unable, less able, and able (Aoyama & Stephens, 2003; Emilia & Amir, 2022; Oktaviyanthi & Agus, 2019). The statistical literacy assessment requirements and indicators are shown in Table 2. The validity of the statistical literacy test instrument by material experts is shown in Table 3.

Table 2. Statistical Literacy Assessment Provisions and Indicators

Indicators→Description	Assessment Requirements	Values
Data Reading Ability: By identifying specific values in the data, students can learn knowledge from the data provided.	Unable to identify the information from the data that has been presented.	0
	Able to identify the information from the data, but there are still inaccuracies.	1
	Able to identify facts or information accurately.	2
Calculating the ratio of data scores: Reading the highest and lowest values in the graph and being able to calculate the ratio of different data scores.	Unable to calculate the ratio of values from the data presented.	0
	Able to calculate the ratio of data values, but there are still inaccuracies.	1
	Able to calculate the ratio of data values accurately.	2
Extracting information: Examining the qualitative information offered by the data to complement the quantitative information.	Unable to extract information.	0
	Able to extract information, but there are still inaccuracies.	1
	Able to extract information from data appropriately.	2

Table 3. Material Expert Validation Instrument

	Assessment Aspects	Question Numbers
Material Expert	Clarity	1,2,3
	Content accuracy	1,2,3
	Relevance	1,2,3
	Content validity	1,2,3
	No bias	1,2,3
	Language accuracy	1,2,3

The validity test results are calculated using the Aiken V formula to determine whether the instrument is valid (Aiken, 1985; Danardono et al., 2022). The validity test results are categorized based on the index, which is between 0-1. If the calculation result of the V index obtained is close to 1 or equal to 1, then the validity is high, and if the calculation result of the V index obtained is close to 0 or equal to 0, then the validity is low (Handayani et al., 2022). The validity categories used above can be presented in Table 4.

Table 4. Validity Categories Based on Index

Validity	Categories
>0.8-1.0	High Validity
>0.4-0.8	Medium Validity
< 0.4	Low Validity

Data analysis techniques are used; the first is descriptive statistics to calculate pretest-posttest scores between the two classes. Second, using the normalized gain formula to determine the achievement and improvement of statistical literacy scores in the low, medium, and high categories, then classified by category of N-Gain (Emilia & Amir, 2022; Hake, 1998; Meltzer, 2002). The N-Gain categories are high improvement of more than 0.7, moderate improvement of less than equal to 0.3-0.7, and low improvement of less than 0.3. Third, using the Shapiro-Wilk test to see if the variance is normal. Fourth, using the Wilcoxon test to evaluate the hypothesis based on the research findings to measure the significance level of the DAPIC problem-solving process on students' statistical literacy.

3. RESULT AND DISCUSSION

Result

Research conducted at Candinegoro State Elementary School in sixth-graders as the experimental group and the control group revealed that the DAPIC problem-solving process had an effect on the improvement of students' statistical literacy. The results of the calculation of descriptive statistics for the two categories of statistical literacy scores are presented in Table 5.

Table 5. Descriptive Statistics between Experimental and Control Classes

Statistical Literacy Score	Number of Respondents	Statistical Range	Minimum	Maximum	Average	Standard Deviation
Pre-Experiment	19	65	25	89	59.95	17.447
Post-Experiment	19	65	25	89	74.16	20.260
Pre-Control	19	48	12	60	37.32	10.531
Post-Control	19	47	25	72	52.53	16.225
Valid N (listwise)	19					

The results of the analysis in Table 5 show that there is a significant difference before and after learning between the two classes. The experimental class had a minimum score of 25 on the pretest and a minimum score of 25 on the post-test. In addition, the maximum value during the experimental class pretest was 89, then the maximum value during the post-test was 89. The difference was striking before and after being given treatment in the experimental class. The pretest average was 59.95 and the post-test average was 74.16. On the other hand. The control class had a pretest mean score of 37.32; the post-test mean score increased by 52.53. This illustrates the difference in average scores between experimental and control classes in statistical literacy learning. After that, the levels of statistical literacy scores in the experimental and control classes are presented in Table 6.

Table 6. Statistical Literacy Score Levels in Experimental and Control Classes

Statistical Literacy Score Level	Experiment Class			Control Class		
	Pre	Post	Gain	Pre	Post	Gain
Low	54	60	0.12	25	30	0.07
Medium	60	77	0.43	42	65	0.40
High	42	89	0.81			
Overall	52	75.33	0.45	33.5	47.5	0.24

The analysis results in Table 6 show an increase in statistical literacy scores between the experimental and control classes. Based on the level of statistical literacy scores at a moderate level (less than equal to 0.3-0.7), the overall average N-Gain results have increased. The overall N-Gain value of the experimental class was 0.45 and the overall N-Gain value of the control class was 0.24. At a high level for the experimental class, the N-Gain value was 0.81; for the control class, there was no N-Gain value. At a moderate level for the experimental class, the N-gain value was 0.43; for the control class, the N-Gain value was 0.40. At the low level for the experimental class, the N-Gain value was 0.12; for the control class, the N-Gain value was 0.07. Meanwhile, the normality test is presented in Table 7.

Table 7. Normality Test of Statistical Literacy

	Shapiro Wilk Test		
Statistical Literacy	Statistics	df	Sig.
Achievements	0.941	19	0.274
Improved	0.766	19	0.000

Table 7 presents the normality test results using the Shapiro-Wilk test in SPSS version 26. A significance level of α = 0.05 was used to measure elementary school students' statistical literacy achievement and improvement. The significance value on the achievement of statistical literacy results is 0.274 and the significance value on the improvement of statistical literacy results is 0.000. This shows that the achievement of statistical literacy results is normally distributed because the significance value is greater than 0.05, while the improvement of statistical literacy results is not normally distributed due to the significance value being less than 0.05. The significance values were different, so both data were analyzed using data interpretation at each level of the statistical literacy score. Data interpretation is presented in Figure 2 and Figure 3.

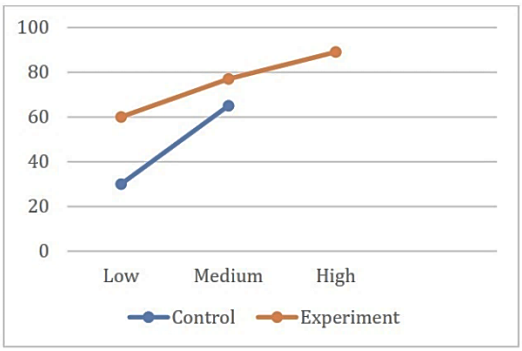


Figure 2. Interaction of Statistical Literacy Score Achievement Based on Levels

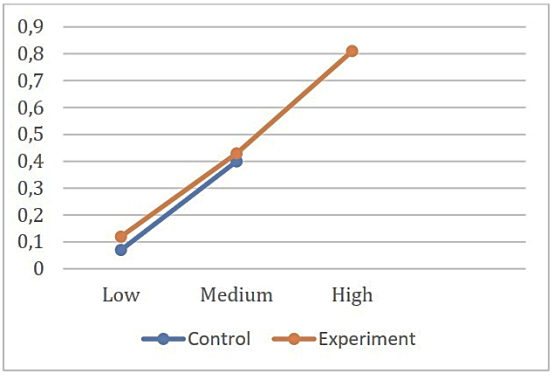


Figure 3. Interaction of Statistical Literacy Score Improvement Based on Levels

Figure 2 and Figure 3 show that all levels of statistical literacy scores in the experimental class on achievement and improvement data were higher than those in the control class. Meanwhile, the experimental and control classes experienced increased statistical literacy scores. The comparison between the two classes lies in the post-test scores, but the difference is not significant. The statistical literacy scores in the experimental class were higher than in the control class. This shows that the DAPIC

problem-solving process has an effect on elementary school students' statistical literacy. Table 8 presents the results of the Wilcoxon test.

Table 8. DAPIC Problem-Solving Process on Statistical Literacy Using Wilcoxon Test

Statistical Literacy Score	Experiment	Control
Asymp. Sig. (2-tailed)	0.002	0.002
Z	-3.043[b]	-3.162[b]

The analysis results in Table 8 show that the probability value (Sig.) is 0.002, which is below 0.05 is the significance threshold. There is a significant difference between the two classes, which can be seen from the results of the Sig. (2-tailed) is less than 0.05. Therefore, it is concluded that the DAPIC problem-solving process positively impacts the statistical literacy of elementary school students.

Discussion

The results of this study showed that there was a significant difference between the experimental and control classes. The experimental class had better results on statistical literacy than the control class. This indicates that the DAPIC problem-solving process affects students' problem-solving process. Students can solve problems appropriate to their ability level and related to their daily lives. Students' ability levels are differentiated into high, medium, and low levels. The experimental class had a better level advantage when compared to the control class. This study's results align with previous studies on statistical literacy in elementary schools. The students' statistical literacy scores increase can be observed according to each level (Emilia & Amir, 2022; Johannis Takaria & Melvie Talakua, 2018; Takaria & Rumahlatu, 2016). The results of another study showed that the improvement of statistical literacy in the experimental class was much better than in the control class. A significance value (sig.) of 0.012 and 0.010 was obtained in the normality analysis using the Shapiro-Wilk test on achievement. The results illustrate that the data is not normally distributed (Emilia & Amir, 2022; Priyambodo & Maryati, 2019). Based on the post-test scores, there is a significant difference between the experimental and control classes. The experimental class obtained higher achievement than the control class. This is in line with previous research that the experimental class obtained good results in the post-test compared to the control class (Guven et al., 2021; Johannis Takaria & Melvie Talakua, 2018; Risnanosanti & Ristontowi, 2019; Takaria & Rumahlatu, 2016). The lack of ability to achieve statistical literacy in the control class is due to the lack of problem-solving in less-than-optimal learning. Low achievement of statistical literacy usually occurs when students are less able to understand the concepts presented in the problem, so students cannot solve the problem properly.

The results of previous research on the DAPIC problem-solving process on improving students' mathematical literacy showed a difference in the average comparison of mathematical literacy in the experimental and control classes after treatment. The average of the experimental class was 22.442 and the control class was 19.423 after the treatment. The mathematical literacy skills of students in the experimental class who received teaching through the DAPIC problem-solving process increased significantly compared to before teaching and higher than in the control class (Sumirattana et al., 2017; Wulandari et al., 2020). Previous research on the development of mathematical literacy through the DAPIC problem-solving process showed that the N-Gain values produced between the experimental and control classes were much different (Risnanosanti & Ristontowi, 2019; Sumirattana et al., 2017).

This research benefits elementary school students by improving their statistical literacy through the DAPIC problem-solving process. Through this problem-solving process, students can develop a problem-solving process that is under problems in their lives and can improve the quality of learning under problems in everyday life (Masjaya et al., 2022; Paramita et al., 2019). This research contributes to improving students' problem-solving process by using the DAPIC problem-solving process that focuses on problems in everyday life to enhance students' statistical literacy skills. The significance of this study is the application of the DAPIC problem-solving process to the statistical literacy of elementary school students. Using the DAPIC problem-solving process in statistical literacy learning has an impression on sixth-grade elementary school students. In the DAPIC problem-solving process, students can use the methods they have experienced in their daily lives to facilitate problem-solving in mathematics learning on statistical literacy material. The DAPIC problem-solving process used in this study is still limited to statistical literacy material only. For further research, it is recommended to use the DAPIC problem-solving process in other mathematics materials at the elementary school level.

4. CONCLUSION

The DAPIC problem-solving process influences the statistical literacy of elementary school students. Using this problem-solving process, students can solve problems using methods relevant to their daily lives. The data analysis results show differences in learning after and before using the DAPIC problem-solving process on statistical literacy material. Therefore, the DAPIC problem-solving process is appropriate for use in learning statistical literacy materials for elementary school students.

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