Year Four Pupils' Performance in Solving Word Problems and School-type Difference

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Abstract: The objectives of this study were to profile Year Four pupils' performance in solving word problems involving perimeter formulae and determine whether there is a significant difference in their performance in terms of school type. The sample of the study consisted of 600 pupils from three types of primary schools in Penang, Malaysia, that is 200 pupils from National School (NS), Chinese National-Type School (CNTS) and Tamil National-Type School (TNTS) each. The results showed that the NS *(M = 5.20)* and CNTS *(M = 6.70)* pupils' performance was in the average category while the TNTS *(M =3.95)* pupils' performance was in the low category. The result of the Kruskal-Wallis *H* Test showed that there is a significant difference in their performance in terms of school type. The post-hoc test using Mann-Whitney *U* Test showed that there is a significant difference in their performance between NS and CNTS, NS and TNTS, and CNTS and TNTS.These results imply that mathematics teachers need to shift the focus of mathematics teaching and learning from procedural understanding itself to both conceptual and procedural understanding so that pupils can better understand and effectively solve word problems involving perimeter formulae in the primary schools.

Keywords: word problems, school type, perimeter formulae, primary school

1. Introduction

The topic of perimeter formulae is essential because it is used in everyday life and it allows primary pupils to learn and apply other important mathematical concepts and skills such as number operations, geometrical ideas, and notions of function (National Council of Teachers of Mathematics, 2000). As such, the topic of perimeter formulae constitutes an important part of the Malaysian Standard Curriculum for Primary Schools. In the Standard Curriculum for Primary Schools, primary school pupils in Year Four begin to learn the perimeter formula of a square, rectangle, and triangle and solve word problems involving the perimeter formulae (Malaysian Ministry of Education, 2013). In Year Five, they begin to learn how to calculate the perimeter of composite two-dimensional shapes involving squares, rectangles, and triangles and solve word problems involving perimeter of composite two-dimensional shapes (Malaysian Ministry of Education, 2014). At the end of primary school, that is in Year Six, they learn how to calculate the perimeter and area of composite two-dimensional shapes involving two or more quadrilaterals and triangles as well as solve word problems involving perimeter and area of composite two-dimensional shapes (Malaysian Ministry of Education, 2015).

However, the performance of Year Six pupils in solving word problems involving perimeter formulae in the national Primary School Achievement test was reported as average by the Malaysian Examinations Syndicate. For example, in finding the perimeter of a whole diagram (which consists of three congruent right-angled triangles with two of the triangles having a common hypotenuse to form a rectangle), the Year Six pupils often made the following mistakes, namely added the common hypotenuse which is located inside the diagram or calculated the perimeter of one right-angled triangle and then multiplied the perimeter by three (Malaysian Examinations Syndicate, 2005). Apart from that, the Year Six pupils also often made the following mistakes when finding the perimeter of a whole diagram which consists of a right-angled triangle and a rectangle: (a) unable to find the length of sides without given measurement; or (b) adding the length of the side which is located inside the diagram (Malaysian Examinations Syndicate, 2008). Additionally, in finding the perimeter of a shaded region the Year Six pupilsalso often made mistakes by adding the length of all the sides or some of the sides of the given diagram containing the shaded region instead of adding the length of all the sides of the shaded region (Malaysian Examinations Syndicate, 2010).

In the Trends in International Mathematics and Science Study 2011, Malaysian Form Two students' performance in solving word problems involving perimeter formulae was also reported as low. For instance, only 43% of Malaysian Form Two students were able to find the perimeter of a square with a given area of 144 cm^2 correctly as compared to 79% of their Singaporean counterparts. As such, Malaysian Form Two students' performance was ranked 25th while the performance of their Singaporean counterparts was ranked first. In addition, the percent correct of Malaysian Form Two students was slightly lower than the international average of 45% (Foy, Arora & Stanco, 2013).

Based on the above performance, there is an urgent need to improve Malaysian primary pupils' performance in solving word problems involving perimeter formulae and it is better to begin from the first year in which primary pupils start to learn the perimeter formulae in school that is Year 4.

2. Literature Review

Solving mathematics word problemshas been difficult for primary pupilsin many countries. This is because to solve a word problem successfully, pupils need to read and understand the word problem before they plan the strategy to solve it (Polya, 1945). Therefore, mastering literacy skills is essential forpupils to read and understand the word problem and transform it into a mathematical sentence to solve it (O'Connor & Norton, 2020). As such, pupils who have a poor mastery of literacy skills may face difficulties in solving the word problem (Pongsakdi et al., 2020).

According to O'Connor and Norton (2020), for pupils to correctly solve a word problem, they need to form a correct mathematical sentence. To do so, they must be able to identify the numerical quantities given in the word problem, determine the relationships between the quantities and find the quantity required by the word problem (Fuch et al., 2020). Next, pupils need to apply a correct mathematical operation using the numerical values to solve the word problem.In this regard, a lack of conceptual understanding may hinder pupils from choosing an appropriate mathematical operation and applying the correct mathematical concepts to solve the word problem(Crooks & Alibali, 2014).Besides, they may not be able to perform the correct mathematical operationif they have weak procedural skills (Daroczy et al., 2015). Hence, poor mastery of numeracy skills, weak conceptual understanding and weak procedural skills may contribute to pupils' failure in solving the word problems (Crooks & Alibali, 2014; Daroczy et al., 2015; Fuch et al., 2020; O'Connor & Norton, 2020).

In addition, pupils' negative attitude towards word problems may also hinder them from successfully solving the word problems (Khoshaim, 2020). Lack of motivation is also a major factor that contributes to pupils' failure in solving the word problems (Nor et al., 2016). Althoughsometimes pupils have sufficient literacy skills and mathematical knowledge, they may choose not to even attempt to solve the word problems due to lack of motivation (Khoshaim,2020). They may also avoid solving word problemsaltogether, thus failing to develop theconceptual understanding and procedural skills required for correctly solving the word problems (Akhter & Akhter, 2018).

Past studies have indicated that the difference in mathematics achievement among different types of primary schools could be due to the medium of mathematics instruction used in the schools. Vukovic and Lesaux (2013) highlighted that language may affect students' interpretation of mathematical ideas. Han and Ginsburg (2001) suggest that languages that have a simpler vocabulary and consistent number system may help pupils understand mathematical concepts easier. Lim (2003) found that since Mandarin or the Chinese language used as the medium of instruction in the CNTS has a simpler vocabulary and a more consistent number system than the other languages used as the medium of instruction in the NS and TNTS, the pupils from the CNTS had a better acquisition of number concepts than the pupils from the NS and TNTS. Hence, the medium of mathematics instruction might be a factor that contributes to the school-type difference in pupils' performance in solving word problems involving perimeter formulae.

Past studies have also indicated that the teaching approach used in the different types of primary schools might also contribute to the mathematics achievement differences. For example, Lim (2003) and Ghazali and Sinnakaudan (2014)revealed that the mathematics lessons in the CNTS focused more on the mathematical concept explanation in addition to drill and practice. But the mathematics lessons in the NS and TNTS focused more on practising the procedural skills than the mathematical concept explanation (Ghazali & Sinnakaudan, 2014). Thus, the pupils from the CNTS had better conceptual understanding and procedural skills as compared to the pupils from the NS and TNTS (Ghazali & Sinnakaudan, 2014). This implies that teaching approach used in each type of primary school might contribute to the school-type difference in pupils' performance in solving word problems involving perimeter formulae.

Further, Ghazali and Sinnakaudan (2014) also found that the teachers in NS, CNTS and TNTS held different beliefs about mathematics teaching and learning. The researchers discovered that most of the CNTS teachers possessed constructivist belief about mathematics teaching and learning and that they emphasised conceptual learning over procedural learning. However, the TNTS and NS teachers believed in teacher-centred teaching that focused more on procedural learning rather than on conceptual learning (Ghazali & Sinnakaudan, 2014) because the teachers considered that clear explanations followed by exercises and practices were sufficient for mathematical learning (Roscoe & Sriraman, 2011). Nevertheless, the teachers fromCNTS, NS and TNTS believed that the pupils might not be able to solve the word problems without their guidance (Ghazali & Sinnakaudan,

2014). Thus, the different beliefs held by the teachers in each type of the primary schools might also contribute to the school-type difference in pupils' performance in solving word problems involving perimeter formulae.

However, past studies have yet to investigate Year Four pupils' performance in solving word problems involving perimeter formulae and whether the performance is significantly different among the pupils from the three types of primary schools in Malaysia. To fill this research gap, this study sought to answer the following research questions:

1. What is Year Four pupils' performance in solving word problems involving perimeter formulae in NS, CNTS and TNTS?
2. Is there any significant difference in Year Four pupils' performance in solving word problems involving perimeter formulae among the pupils from the three types of primary schools?

To answer research question 2, the null and alternative hypotheses were formulated and evaluated at the significance level of .05 as follows:

Ho: There is no significant difference in Year Four pupils' performance in solving word problems involving perimeter formulae among the pupils from the three types of primary schools.

Ha: There is a significant difference in Year Four pupils' performance in solving word problems involving perimeter formulae among the pupils from the three types of primary schools.

3. Methodology

Research design

A cross-sectional survey research design was used answer the research questions because it can provide a profile of the Year Four pupils' performance in solving word problems involving perimeter formulae in the three types of schools efficiently and economically at a single point of time and to determine whether the performance is significantly different among the pupils from the three types of primary schools (Gay, Mills, & Airasian, 2012).

Population and Sample

Due to practical constraints and COVID-19 pandemic, the accessible population of the study were Year Four pupils in the Penang state of Malaysia. The sample of the study was chosenby using proportional stratified cluster sampling to ensure the representation of relevant strata within the sample (Gay et al., 2012). The accessible population was first stratified into three strata based on school type, that isNational School (NS), Chinese National-Type School (CNTS) and Tamil National-Type School (TNTS). The three types of primary schools use the same mathematics curriculum but the medium of instruction for mathematics lessons is different. That is,NS pupils use Malay language, CNTS pupils use Mandarin while TNTS pupils use Tamil language to learn mathematics in the classroom. After stratifying the population by school type, the sample of the study was randomly selected by cluster (which was defined as a school) in each stratum. As such, all Year Four pupils in the selected schools would be chosen as the sample of the study. As shown in Table 1, 600Year Four pupils from NS (200), CNTS (200)and TNTS(200)were selected as the sample of the study.

Table 1. Sample of the Study

	Gender		
School Type	Female	Male	Total
NS	97	103	200
CNTS	95	105	200
TNTS	94	106	200
Total	286	314	600

Word Problem Test

The Year Four pupils' performance in solving word problems involving perimeter formulae was measured by using the Word Problem Test (WPT). The WPT consisted of three open-ended word problems adapted from the Year Four mathematics textbook. The first word problem measured Year Four pupils' performance in solving word problem involving perimeter formula of a square, the second measured the pupils' performance in solving word problem involving perimeter formula of a rectangle, while the third measured the pupils' performance in solving word problem involving perimeter formula of a triangle as specified in the Standard Curriculum for

Primary Schools. The score for each word problem ranged from 0-4 marks. The WPTwas developed in English and translated into Malay, Mandarin or Tamil language to match the medium of mathematics instruction used in the NS, CNTS or TNTS, respectively. The Malay, Mandarin and Tamil versions of the WPT were validated by six subject matter experts who are experienced Year Four mathematics teachers, that is two from the NS, CNTS and TNTS each, to ensure the item relevance and the content coverage of the WPT. The results of the validation are shown in Table 2. The S-CVI for content coverage and item relevance was 1.00 (surpassing the minimum threshold of .80) for all the three types of schools, indicating that the WPT had high content coverage and item relevance (Polit & Beck, 2006). Next, Cronbach's Alpha was used to determine the reliability of each version of the WPT. With the Cronbach's Alpha value of .72, .88 and .78 respectively, the Malay, Mandarin and Tamil versions of the WPT were considered reliable to be used in the actual study (Pallant, 2016).

Table 2. Validity and Reliability of WPT

School type (Version)	Content Coverage (S-CVI)	Item Relevance (S-CVI)	Reliability (Cronbach's Alpha)
NS (Malay)	1.00	1.00	.72
CNTS (Mandarin)	1.00	1.00	.88
TNTS (Tamil)	1.00	1.00	.78

4. Results and Discussion

(i) Profile of Year Four pupils' performance in solving word problems involving perimeter formulae by school type

Table 3 shows the profile of the Year Four pupils' performance in solving word problems involving perimeter formulaein NS, CNTS and TNTS.For NS, the highest number of pupils (58 or 29.0%) were in the low category of performance in solving the word problems involving perimeter formulae while the lowest number of pupils (23 or 11.5%) were in the very high category of performance in solving the word problems. For CNTS, the highest number of pupils (77 or 38.5%) were in the very high category of performance in solving the word problems involving perimeter formulae while the lowest number of pupils (12 or 6.0%) were in the average category of performance in solving the word problems. For TNTS, the highest number of pupils (93 or 46.5%) were in the very low category of performance in solving the word problems involving perimeter formulae while the lowest number of pupils (17 or 8.5%) were in the very high category of performance in solving the word problems. Overall, the mean score indicates that the NS *(M* = 5.20*)* and CNTS *(M* = 6.70*)* pupils' performance was in the average category while the TNTS *(M* =3.95*)* pupils' performance was in the low category.

Table 3. Profile of Year Four Pupils' Performance in Solving Word Problems by School Type

Performance in Solving Word Problems	NS		CNTS		TNTS	
	n	%	*n*	%	*n*	%
Very Low (0-1 mark)	45	22.5	51	25.5	93	46.5
Low (2-4 marks)	58	29.0	32	16.0	26	13.0
Average (5-7 marks)	30	15.0	12	6.0	22	11.0
High (8-10 marks)	44	22.0	28	14.0	42	21.0
Very High (11-12 marks)	23	11.5	77	38.5	17	8.5
Total	200	100.0	200	100.0	200	100.0
Mean score	5.20 (Average)		6.70 (Average)		3.95 (Low)	

(ii) Difference in Year Four pupils' performance in solving word problems involving perimeter formulae among the three types of primary schools

Before conducting the one-way ANOVA, the assumptions of normality and homogeneity of variances were tested. As shown in Table 4, the results of the Kolmogorov-Smirnov test for the three types of primary schools are significant ($p < .05$) indicating that the scores of the performance in solving the word problems involving perimeter formulae for the three types of primary schools are not normally distributed(Pallant, 2016).

Table 4. Results of Kolmogorov-Smirnov Test

		Kolmogorov-Smirnov		
	Type of school	Statistic	df	Sig.
Performance scores in solving word problems	NS	.132	200	.000
	CNTS	.240	200	.000
	TNTS	.284	200	.000

From Table 5, the result of the Levene's test is significant ($p < .05$) indicating that the scores of the performance in solving the word problems involving perimeter formulae do not have homogeneity of variances(Pallant, 2016).

Table 5. Results of Levene's Test

	Levene Statistic	df1	df2	Sig.
Performance scores in solving word problems	18.926	2	597	.000

Since the assumptions of normality and homogeneity of variances for the one-way ANOVA are violated, the Kruskal-Wallis *H*test was conducted to determine whether there is a significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae among the three types of primary schools(Pallant, 2016). Table 6 shows the result of the Kruskal-Wallis *H*test. The result shows that there is a significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae among the three types of primary schools, H (2) = 37.02, p = .001, with a mean rank of 301.11 for the NS pupils, 351.87 for the CNTS pupils and 248.52 for the TNTS pupils.

Table 6. Result of Kruskal-Wallis *H* Test

	Mean Rank					
	NS (n = 200)	CNTS (n = 200)	TNTS (n = 200)	Kruskal-Wallis *H*	*df*	*p*
Performance scores in solving word problems	301.11	351.87	248.52	37.02	2	0.001

Since Kruskal-Wallis *H* test revealed a statistically significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae among the three types of primary schools, a post-hoc test using the Mann-Whitney *U*test with Bonferroni correction ($p = .05 \div 3 = .017$) was used to determine which pair of schools is statistically different from one another(Pallant, 2016).

Table 7 shows the result of the Mann-Whitney *U*test for the comparison between NS and CNTS. The result shows that there is a significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae betweenNS and CNTS, $U(N_{NS} = 200, N_{CNTS} = 200) = 16359.00$, Z = -3.20, p = .001 with the CNTS (218.71) pupils having a higher mean rank than the NS (182.30) pupils.

Table 7. Result of Mann-Whitney *U* Test for NS and CNTS

	Mean Rank				
	NS (n = 200)	CNTS (n = 200)	Mann-Whitney *U*	*Z*	*p*
Performance scores in solving word problems	182.30	218.71	16359.00	-3.20	0.001

Table 8 shows the result of the Mann-Whitney *U* test for the comparison between NS and TNTS. The result also shows that there is a significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae between NS and TNTS, U ($N_{NS} = 200, N_{TNTS} = 200$) = 16237.00, Z = -3.33, p = .001 withthe NS (219.32) pupils having a higher mean rank than the TNTS (181.69) pupils.

Table 8. Result of Mann-Whitney *U* Test for NS and TNTS

	Mean Rank		Mann-Whitney *U*	*Z*	*p*
	NS (n = 200)	TNTS (n = 200)			
Performance scores in solving word problems	219.32	181.69	16237.00	-3.33	0.001

Table 9 shows the result of the Mann-Whitney *U* test for the comparison between CNTS and TNTS. Likewise, the result shows that there is a significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae between CNTS and TNTS, U (N_{CNTS} =200, N_{TNTS} =200) = 13367.50, Z = -5.91, p = .001 with the CNTS (233.65) pupils having a higher mean rank than the TNTS (167.34) pupils.

Table 9. Result of Mann-Whitney *U* Test for CNTS and TNTS

	Mean Rank		Mann-Whitney *U*	*Z*	*p*
	CNTS (n = 200)	TNTS (n = 200)			
Performance scores in solving word problems	233.65	167.34	13367.50	-5.91	0.001

5. Discussion

In general, the average performance of the NS and CNTS Year Four pupils in solving word problems involving perimeter formulae are quite in line with the reports by the Malaysian Examinations Syndicate (2005, 2008, 2010) that the performance of Year Six pupils in solving word problems involving perimeter formulae in the national Primary School Achievement test was in the average category. However, the low performance of the TNTS Year Four pupils in solving word problems involving perimeter formulae does not concur with the reports by the Malaysian Examinations Syndicate (2005, 2008, 2010). Nevertheless, the low performance of the TNTS Year Four pupils in solving word problems involving perimeter formulae reflects the result of the Trends in International Mathematics and Science Study 2011 that Malaysian Form Two students' performance in solving word problems involving perimeter formulae was low and as a result it was slightly lower than the international average of 45% (Foy, Arora & Stanco, 2013).

In addition, the result of the Kruskal-Wallis *H* test which revealed a statistically significant difference in the Year Four pupils' performance in solving word problems involving perimeter formulae among the three types of primary schools and the results of the post-hoc test (Mann-Whitney *U* test with Bonferroni correction) which indicated that the pupils from CNTS performed better than their counterparts from NS and TNTS generally support the result of the study by Ghazali and Sinnakaudan (2014). The researchers found that the pupils from CNTS had better conceptual understanding and procedural skills as compared to their counterparts from NS and TNTS. This significant school-type difference in the Year Four pupils' performance in solving word problems involving perimeter formulae could be due to the medium of mathematics instruction used in the three types of primary schools. According to Vukovic and Lesaux (2013), language could affect students' interpretation of mathematical ideas. Since the Chinese language or Mandarin has a simple and consistent number system, it might help the CNTS pupils better understand number concepts and solve the word problems more effectively than the NS and TNTS pupils (Han & Ginsburg, 2001; Lim, 2003).

In addition, the teaching approach used in each school type might also contribute to the performance difference in solving word problems involving perimeter formulae among the three types of primary schools. Ghazali and Sinnakaudan (2014) as well as Lim (2003) found that the mathematics lessons in the CNTS focused more on the explanation of concepts apart from drill and practice. On the contrary, the mathematics lessons in the NS and TNTS focused more on practising the procedural skills involving arithmetic operations. Thus, the pupils from CNTS would have better understanding of concepts and computational skills which in turn might help them to perform better in solving the word problems involving perimeter formulae as compared to the pupils from NS and TNTS (Ghazali & Sinnakaudan, 2014).

Furthermroe, Ghazali and Sinnakaudan (2014) found that the mathematics teachers in the three types of primary schools held different beliefs about mathematics teaching and learning. Most of the CNTS teachers held a constructivist belief about mathematics teaching and learning, and they therefore emphasised conceptual

learning over procedural learning. In contrast, the NS and TNTS teachers practised teacher-centred approach which focused more on procedural skills (Ghazali & Sinnakaudan, 2014) because they believed that clear explanations followed by practices or exercises were sufficient for mathematical learning (Roscoe & Sriraman, 2011). The constructivist belief about mathematics teaching and learning of the CNTS mathematics teachers might have contributed to the better performance of the CNTS pupils in solving the word problems involving perimeter formulae as compared to that of their counterparts from the NS and TNTS.

6. Conclusion

In conclusion, this study provides a profile of the Year Four pupils' performance in solving word problems involving perimeter formulae in NS, CNTS and TNTS. The mean score generally indicates that the NS and CNTS pupils' performance was in the average category while the TNTS pupils' performance was in the low category. Although, the NS and CNTS pupils' performance was in the same average category, the CNTS pupils performed significantly better in solving the word problems involving perimeter formulae than the NS pupils and the NS pupils performed significantly better than the TNTS pupils. These results imply that mathematics teachers need to shift the focus of mathematics teaching and learning from procedural understanding itself to both conceptual and procedural understanding so that pupils can better understand and effectively solve the word problems involving perimeter formulae in the primary schools. These results also imply an urgent need for effective remedial teaching to improve the Year Four pupils' performance in solving word problems involving perimeter formulae in NS, CNTS and TNTS. Lastly, further studies are recommended to investigate effective teaching approaches to enhance Year Four pupils' performance in solving word problems involving perimeter formulae in NS, CNTS and TNTS.

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