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Instrumental and Relational Understanding in Math Problem Solving Among Grade V Pupils

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ABSTRACT

In teaching mathematics, the essential task of the teachers is to motivate their students to understand and appreciate the concepts and usefulness of mathematics. This study determined the mathematics performances of the Grade V pupils in the context of Skemp's (1976) relational and instrumental concepts of understanding. The study utilized the descriptive-comparative method of research using a researcher-made test to gather data on the performances of the Grade V pupils in instrumental and relational understanding types of tests. Most of the pupils involved in the study failed in the instrumental type of test and more so in the relational type of test. The majority of schools manifest significant differences in the pupils' performance in the instrumental and relational types of tests. Based on the mean scores, the pupils' performances in the relational type of test is more deficient than the instrumental type of test. The analysis of variance and the post hoc test supports the idea that there is a variation in pupils' performances in the instrumental type of test. Likewise, a variation in the relational type of test exists.

Keywords: *Mathematics, problem-solving, instrumental understanding, relational understanding, teaching and learning, descriptive-comparative research, Philippines*

INTRODUCTION

Mathematics teaching today rests on the assumption that teachers are important figures in improving the teaching and learning of mathematics (Ferri, 2018). Consequently, the teacher must have long-term support and adequate resources to engage the students effectively in the teaching-learning process (Liu, Chen, Lin, & Huang, 2017). Teachers' primary concern in the classroom is to deliver the lesson. Motivating the students to understand and appreciate various mathematical concepts is considered an essential task of the teachers (Simamora & Saragih, 2019). Hence, teachers need to innovate (Wang, Utemov, Krivonozhkina, Liu, & Galushkin, 2018) and make their examples as realistic as possible. Relatable and straightforward math problems would make the students enjoy the topic and learn more (Clarke & Roche, 2018; Menanti, Sinaga, & Hasratuddin, 2018). Although some students understand the lessons and do well, they hate the subject because they cannot see real-life applications. For them to love math is by making it practical and relatable (Batool, 2019).

Exposing young learners to math word problems would enhance their potentials in choosing and applying varied strategies in handling real-life problems (Dröse & Prediger, 2019). The working memory capacity of children with difficulties in learning mathematics constitutes a moderating effect of the selected teaching strategy. The advantages of children with high functional memory capacity on performing better than their counterparts depend on the type of teaching strategy that motivates them and catches their attention. Some teaching strategies do not yield excellent outcomes. However, those strategies which focus on capturing the attention of the pupils to engage in the lesson benefitted both learners with high and low working memory capacity (Swanson, 2016).

Ideally, mathematics classrooms should offer students an environment with equal opportunity to learn, a balanced focus on conceptual understanding, and procedural fluency (Smith & Freels, 2017). It encourages the students to engage actively in problem-solving, reasoning, communicating, making connections (Santos-Trigo & Reyes-Martínez, 2019), and using multiple representations (Kang & Liu, 2018). Mathematics classrooms should also be technologically well-equipped learning centers. Technology is readily accessible to enhance understanding, aside from incorporating various assessments compliant with the instructional goals and practices. As a result, the students will manifest a good performance (Young, 2017).

A study conducted in New Zealand advocated using challenging tasks as an innovative approach to teach mathematics. The researchers believe that students learn mathematics best when they build connections between mathematical ideas for themselves. In challenging mathematics tasks, students are encouraged to think for themselves, discuss mathematics, determine appropriate strategies, and establish connections. The goal of the approach is to bring out the students from the habit of applying mathematical concepts and rules without deeply understanding the problem (instrumental approach). As a result, the students would engage in a situation where they have to seek a more profound understanding and connections of the various mathematical concepts to a specific problem (relational approach) (Ingram et al., 2019).

In educational psychology, personalizing problems is an effective teaching strategy. Personalized questions can elicit the students' interest to engage and re-engage with specific ideas (Bernacki & Walkington, 2018). In the cognitive view, learning is extending and transforms existing knowledge. On the older beliefs of cognition, the emphasis is on knowledge acquisition. However, the newer approaches to understanding emphasized knowledge construction. Among constructivists, learning is on knowledge in use rather than the storing of inert facts, concepts, and skills. Learning objectives include developing abilities to find and solve ill-structured problems, critical thinking, inquiry, self-determination, and openness to multiple perspectives (Wolfolk, 2016). However, several math teachers indicated that their students struggled with representation and understanding math problems. The causes of students' difficulties include text difficulties, unfamiliar contexts, and using inappropriate strategies. Embedding math word problems in a more familiar context would turn it more comfortable for students (Macdonald & Banes, 2017).

The result of the examination conducted by Trends in International Mathematics and Science Study (TIMSS) in 1999 showed that the Philippines was ranked 36th in mathematics and science among 38 participating countries. In TIMMS 2003, the Philippines was listed in 23rd place among 25 participating countries in Grade 4 science and mathematics. Furthermore, the country was in 42nd place in science and 41st in mathematics among 45 countries for second-year high school (Gonzales et al., 2004). In March 2019, the Philippines participated again in the said survey. Based on the results, the overall performance of Filipino Grade 4 pupils is ranked the lowest among fifty-eight countries that participated in the said international assessment (Baclig, 2021).

Literature search reveals that there are studies that focus on specific math concept (Anwar, Yuwono, & As'ari, 2016; Utomo, 2020), the tendency of students to adopt instrumental approach (Anderson, 1996), and exposing students to relational instruction compared to students who received instrumental instruction followed by relational instruction (Pesek & Kirshner, 2000). However, the researchers cannot find a study conducted regarding instrumental and relational understanding in math problem solving among grade school pupils from public schools in the Philippines. Furthermore, the researchers cannot find a study of the variation of the pupils' performances in the instrumental and relational types of tests analyzed in the context of geographical setting.

In the School District of Compostela, located 31 kilometers north of Cebu City, Philippines, the average performance of the pupils in the mathematics component of the Philippines' National Achievement Test (NAT) is consistently below the national passing mark of 75% for the last five years. Such observation became the driving force in conducting this study by looking into the mathematics performances of the Grade V pupils in the context of Skemp's (1976) relational and instrumental concepts of understanding. Furthermore, this study holds on to the theories of cognitive dissonance (Festinger, 1957) and cognitive flexibility

(Spiro, Coulson, Feltovich, & Anderson, 1988). Hopefully this study would provide additional information on the existing literature on students' mathematics performances and encourage other researchers to conduct further studies on this topic.

FRAMEWORK

Skemp (1976) stated that there are two different approaches to understanding: instrumental and relational understandings. Both types of understanding give the correct answers, but relational is much more extensive. Moreover, relational understanding is the one considered the better option over the other. However, there are advantages and disadvantages to both. The favorable outcomes for the first type of understanding are the disadvantages of the other. Instrumental understanding would push the learners to have a mathematical rule and able to use or manipulate it. In short, the learning process involves knowing and applying the rule. As a result, the learner has to remember many separate rules that seem unconnected from each other. Relational understanding would not only push the students to learn the mathematical rule and its uses; but also enable them to know why a rule works and connects with another rule. Many teachers teach instrumental mathematics because it is usually easier for students to understand; the rewards are more immediate and apparent. One can often get the correct answer more quickly and reliably. However, teaching through relational understanding will make students more adaptable to new tasks; they can remember the concept easily; can rationalize knowledge effectively as a goal in itself, and relate to schemas in organic quality. However, a teacher might make a reasoned choice to use instrumental understanding in teaching mathematics for self-convenience.

Meanwhile, Festinger's (1957) theory of cognitive dissonance asserts that in any given situation where two cognitions are inconsistent, one person tends to seek consistency in his/her beliefs and attitudes. As a state of unpleasant psychological tension, cognitive dissonance motivates a person to reduce his/her mental inconsistencies by making his/her views more consistent with his/her behavior. As explained by Baumeister and Bushman (2017), the theory of cognitive dissonance centers on one's effort to reach internal consistency. People's inner needs guarantee the character of their beliefs and views. Disharmony is the result of inconsistent or conflicting beliefs in which people strive to avoid. Cooper (2007) stressed that too personal cognition might lead to more significant dissonance. Belief in highly valued things would lead to more substantial disharmony. The proportion of dissonant thoughts against consonant thoughts could play a role in how strong the feelings of dissonance are. The higher the strength of the dissonance, the more pressure there is to relieve the feelings of discomfort. The three key strategies to reduce or minimize cognitive dissonance include the following: 1) focusing one-self on more reassuring thoughts that outweigh the dissonant belief or behavior, 2) reducing the importance of contradicting belief, and 3) amending the different trust to be consistent with other beliefs or behavior. A person experiencing dissonance has three optional courses of action to minimize the conflict: alter the behavior, amend the belief, or give reasons for the behavior. However, people tend to either change their beliefs or rationalize. The motivation to reduce dissonance may cause irrational or even dangerous behavior.

Additionally, cognitive flexibility theory concerns transferring desired knowledge and skills to any learner beyond the initial learning situation. Its emphasis is on presenting information from multiple perspectives and the use of many case studies that present diverse examples. It also asserts that active learning is context-dependent, so instruction needs to be very specific. On the importance of constructed knowledge, the development of the learners' representation is the prime intention. Complex and ill-structured domains are the foci of the cognitive flexibility theory. The flexibility of cognition refers to the natural ability to restructure knowledge in various ways and adapt to varying situations (Spiro et al., 1988).

Further, cognitive flexibility theory supports the use of interactive technology. In principle, this theory says that learning activities must provide multiple representations of content, avoid oversimplifying the content domain, and support context-dependent knowledge of the instructional materials. Instruction should be case-based and emphasize knowledge construction, non-transmission of information, and knowledge sources should be highly interconnected rather than compartmentalized. Manipulating the way of presenting information and its corresponding processes leads to the cognitive flexibility of the learner (Spiro & Jehng, 2012).

OBJECTIVES OF THE STUDY

The study determined the 1) level of performance in Mathematics of the Grade V pupils in instrumental and relational understanding type of test; 2) the significance of the differences between the pupils' performances in instrumental and relational understanding types of tests per school; 3) the significance of the difference between the pupils' performances in the instrumental and relational type of tests per school; and 4) the significance of the difference among the pupils' performances in the instrumental and relational understanding type of tests when grouped in terms of school.

METHODOLOGY

The study utilized the descriptive-comparative method of research using a researcher-made test to gather data on the performances of the Grade V pupils in instrumental and relational understanding types of tests. The locale of the study is the School District of Compostela - Compostela, Cebu, Philippines. The School District of Compostela is 31 kilometers away from Cebu City, going to the northern part of Cebu Province. Compostela District is composed of 15 complete elementary schools. The research subjects were the Grade V pupils enrolled in the public elementary schools in the District of Compostela, Cebu. The total number of Grade V pupils in the district is 1,127. From this number, 498 pupils composed the research subjects of this study. The sampling technique used is random cluster sampling. One class of Grade V pupils from each school was represented in the survey. The sample size of 498 Grade V pupils represented 51% of the total population of Grade V pupils. The central limit theorem advances that a sample size of 30 or more is considered a large sample. Hence, the sample size of this study is already more than sufficient.

A researcher-made test, prepared based on the math competencies for Grade V pupils, was used to measure the respondents' level of performance in Mathematics using the instrumental and relational understanding approach. Experts in test construction and other math teachers validated the researcher-made tests. After incorporating the suggestions of the validators, the primary researcher subjected the teacher-made tool to pilot testing in one of the Grade V classes in the locality. The pilot testing indicates that both types of researcher-made tests passed the reliability test using Cronbach's alpha. The instrumental type of researcher-made test got a reliability coefficient of 0.81, while the relational kind of test got a reliability coefficient of 0.78. In this study, the researchers utilized the following score ranges and categories of DepEd to summarize the scores of the research subjects; as follows: 0 – 74% described as *beginning*, 75 – 79% described as *developing*, 80 – 84% described as *approaching proficiency*, 85 – 89% described as *proficient*, and 90 – 100% described as *advanced*. The researchers utilized the frequency count, proportion, t-test for paired two samples for means, and the one-way analysis of variance (ANOVA) in summarizing, analyzing, and interpreting the data.

RESULTS AND DISCUSSION

Pupils' Level of Performances in Mathematics

Table 1. Pupils' performances in the instrumental understanding type of test

	Advanced (90-100)	Proficient (85-89)	Approaching Proficiency (80-84)	Developing (75-79)	Beginning (74 & below)	Total	Mean	Rank
School 1*	0	23	13	8	7	51	80.88	2
School 2**	0	0	0	0	35	35	45.71	8
School 3**	0	2	1	0	22	25	61.00	4
School 4*	7	13	6	11	5	42	82.87	1
School 5*	0	2	6	3	27	38	58.19	6
School 6*	0	0	0	1	34	35	52.06	7
School 7**	0	0	0	0	41	41	44.11	11
School 8*	0	0	0	1	39	40	45.00	10
School 9**	0	0	0	0	18	18	42.75	12
School 10**	1	8	6	7	27	49	71.03	3
School 11**	0	0	0	1	23	24	42.59	13
School 12**	0	0	1	5	19	25	60.89	5
School 13**	0	0	0	0	17	17	39.71	15
School 14*	0	0	0	0	32	32	45.31	9
School 15**	0	0	0	0	26	26	39.96	14
Grand Total	**8**	**48**	**33**	**37**	**372**	**498**	**56.89**	
%	***1.61***	***9.64***	***6.63***	***7.43***	***74.70***	***100.00***		

**lowland school; **upland school*

Table 1 shows that the pupils' general performance from the fifteen public schools in the *instrumental type* of test is categorized as *beginning proficiency* (74.70%) with an overall average score of 56.89. Moreover, schools #4 (rank 1) and #1 (rank 2) are the only two schools whose pupils' performances in the instrumental type of test are categorized as *proficient* with average scores of 82.87 and 80.88. These school (#4 and #1) are located in the town proper. Although most pupils' performances of the remaining schools are categorized as *beginning proficiency*, school #10 (rank 3) has some pupils belonging to the higher performance categories with an average score of 71.03. This school is located along the national highway and two kilometers going north from the town proper. Further, the remaining schools are categorized as *beginning* *proficiency* with average scores of less than 70.00. As indicated in Table 1, the top three schools (#4, #1, and #10) are situated in the lowland areas. Meanwhile, the five least performing schools are #7 (rank 11), #9 (rank 12) , #11 (rank 13), #15 (rank 14), and #13 (rank 15). These schools are all situated in remote upland areas. The findings indicate that pupils of schools situated in the town proper and those in school along the national highway have better performances than their counterparts in remote upland areas in the instrumental type of test. It could also mean that the quality of mathematics teaching in the schools situated in the town proper and schools along the national highway is better than the schools situated in the remote upland areas.

Table 2. Pupils' performances in the relational understanding type of test

	Advanced (90-100)	Proficient (85-89)	Approaching Proficiency (80-84)	Developing (75-79)	Beginning (74 & below)	Total	Mean	Rank
School 1*	0	0	5	14	32	51	70.86	2
School 2**	0	0	0	0	35	35	36.92	12
School 3**	0	0	0	0	25	25	45.89	7
School 4*	0	3	11	17	11	42	76.72	1
School 5*	0	1	0	2	35	38	49.56	4
School 6*	0	0	1	2	32	35	48.03	6
School 7**	0	0	0	0	41	41	36.65	13
School 8*	0	0	0	0	40	40	34.53	15
School 9**	0	0	0	0	18	18	37.50	11
School 10*	0	0	2	4	43	49	63.32	3
School 11**	0	0	0	1	23	24	42.36	8
School 12**	0	0	0	1	24	25	48.22	5
School 13**	0	0	0	0	17	17	39.56	10
School 14*	0	0	0	0	32	32	35.78	14
School 15**	0	0	0	1	25	26	40.92	9
Grand Total	***0***	***4***	***19***	***42***	***433***	***498***	**49.42**	
%	***0.00***	***0.80***	***3.82***	***8.43***	***86.95***	***100.00***		

**lowland school; **upland school*

Table 2 shows that the pupils' general performance from the fifteen public schools in the *relational type* of test is categorized as *beginning proficiency* (86.95%) with an overall average score of 49.42. Moreover, school #4 (rank 1) is the only school with pupils› performances categorized under *developing proficiency and* *approaching proficiency* with an average score of 76.72 in the relational type of test. As mentioned earlier, school #4 is located in the town proper. Although most pupils' performances are categorized as *beginning proficiency*, schools #1 (rank 2) and #10 (rank 3) have some pupils belonging to the higher performance categories with average scores of 70.86 and 63.32. School #1 is situated in the town proper, and school #10 is located two kilometers from the town proper but along the national highway. Further, the remaining schools are categorized as *beginning proficiency* with average scores of less than 60.00. Meanwhile, the five least performing schools are #9 (rank 11), #2 (rank 12), #7 (rank 13), #14 (rank 14), and #8 (rank 15). Schools #9, #2, and #7 are upland schools, while schools #14 and #8 are lowland schools. As indicated, only one school from the town proper has performed better in the relational type of test, and the rest have mean scores of less than 75 passing marks. As observed, schools #14 and #8 (lowland schools) are the least performing schools based on the ranking. This observation is fascinating considering that these schools are in the lowland area but far from the town proper and national highway. Other possible factors may have caused this observation but were not captured in this study. Hence, a good material for future researches. Nevertheless, the overall findings indicate that the pupils have more difficulty in the relational type of test. In other words, the majority of the pupils in the participating schools have difficulty answering the mathematical questions written in relational form. Hence, this is a manifestation of their low ability to master the lessons in mathematics.

Differences Between the Pupils' Performances in the Instrumental and Relational Type of Tests per School

Table 3. Significance of the difference between the pupils' performances in the instrumental and relational type of tests per school

School	Instrumental (Mean)	Relational (Mean)	df	t-stat	t-crit	Decision on Ho	Significance
School 1*	80.88	70.86	50	8.475	2.009	Reject Ho	Significant
School 2**	45.71	36.92	34	5.282	2.032	Reject Ho	Significant
School 3**	61.00	45.89	24	6.159	2.064	Reject Ho	Significant
School 4*	82.87	76.72	41	4.670	2.020	Reject Ho	Significant
School 5*	58.19	49.56	37	4.415	2.026	Reject Ho	Significant
School 6*	52.06	48.03	34	2.342	2.032	Reject Ho	Significant
School 7**	44.11	36.65	40	3.783	2.021	Reject Ho	Significant
School 8*	45.00	34.53	39	5.917	2.023	Reject Ho	Significant

School	Instrumental (Mean)	Relational (Mean)	df	t-stat	t-crit	Decision on Ho	Significance
*School 9***	*42.75*	*37.50*	*17*	*1.598*	*2.110*	*Failed to Reject Ho*	*Not Significant*
School 10*	71.03	63.32	48	5.335	2.011	Reject Ho	Significant
*School 11***	*42.59*	*42.36*	*23*	*0.107*	*2.069*	*Failed to Reject Ho*	*Not Significant*
School 12**	60.89	48.22	24	6.262	2.064	Reject Ho	Interpretation
*School 13***	*39.71*	*39.56*	*16*	*0.133*	*2.120*	*Failed to Reject Ho*	*Not Significant*
School 14*	45.31	35.78	31	5.660	2.040	Reject Ho	Significant
*School 15***	*39.96*	*40.92*	*25*	*-0.400*	*2.060*	*Failed to Reject Ho*	*Not Significant*

**lowland school; **upland school;* $\alpha = 0.05$

Table 3 shows that eleven schools have test statistics greater than the critical values at a 0.05 level of significance. Based on their means, the mean scores in the relational type of test are lesser than the mean scores in the instrumental type of test. The results imply that the pupils' performances in the relational type of test are significantly lesser than their instrumental type of test. In other words, the pupils of schools #1, #2, #3, #4, #5, #6, #7, #8, #10, #12, and #14 have more difficulty in answering the relational type of test. Schools #2, #3, and #7 are located in the upland areas, while the rest are located in the lowland areas. These findings indicate that regardless of the geographical location of the schools, students who failed to master the various mathematical concepts and operations would have difficulty answering the instrumental type of test and more difficulty in the relational type of test. This scenario is supported by (Macdonald & Banes, 2017) when they said that many math teachers indicated that their students struggled with representation and understanding the math problems. They stressed that pupils' difficulties in mathematics center on understanding the text used in the word problems and unfamiliarity of the contexts used.

Meanwhile, out of fifteen schools, only four schools have test statistics less than the critical values. It means that there is no sufficient evidence to say that the mean scores in the instrumental type of test are different from the mean scores in the relational type of test. Hence, the pupils' performances from schools #9, #11, #13, and #15 in the instrumental and relational types of tests are relatively similar. As indicated in Table 4, these schools are situated in the upland areas, and the mean scores are far below the 75 passing marks. These findings indicate that the students in these four upland schools may have just guessed in answering the two types of tests. As a result, their scores in the instrumental and relational types of tests are deficient but do not reflect that the relational type of test is more complex than the instrumental type of test. When this group of pupils was answering the tests, their thought is to pass the tests. However, their poor ability and non-mastery of the mathematical concepts and operations give them difficulty answering the tests. As a result, they resort to guessing the answers to complete the tests. The theory of cognitive dissonance (Festinger, 1957) can explain this situation. In the theory of cognitive dissonance, people tend to seek consistency of their beliefs and attitudes when caught in a situation of two conflicting cognitions. Cognitive dissonance gives unpleasant psychological tension, motivating them to reduce their mental inconsistencies by doing things more consistent with their behavior.

Based on the findings, one can say that the pupils involved in this study are more exposed to the instrumental understanding teaching approach than the relational understanding approach. The decreasing trend of the mean scores between the instrumental and relational types of tests is a manifestation of pupils' less exposure to the relational understanding teaching approach. The finding validates Skemp's (1976) explanation that many teachers teach mathematics in the instrumental understanding way because it is easier to manage, and the rewards are more immediate and apparent. Bernacki and Walkington (2018) suggested that personalizing math word problems is an effective teaching strategy to elicit students' interest to engage and re-engage with specific ideas. Activating interest can lead to outcomes such as increased attention, persistence, confidence, and ultimately learning. Bridging what the learners already know and the formal mathematics concepts is the ultimate goal for personalizing problems.

Additionally, Spiro et al. (1988) emphasized that information, like mathematics, should be presented from multiple perspectives and diverse examples. The development of a learner's representation is significant in knowledge construction. Hence, active learning should be context-dependent. Spiro and Jehng (2012) reiterated that learning activities must provide multiple representations of content. Moreover, oversimplifying the content domain must be avoided. Further, they encourage support on context-dependent knowledge of the instructional materials.

Differences of the Pupils' Performances Among Schools

Table 4. Significance of the differences in pupils' performances in instrumental type of test

Variables	Source of Variation	SS	df	MS	F	P-value	F crit	Significance
Pupils' Performances in Instrumental Type of Test Among Schools	Between Groups	111,204.830	14	7,943.202	52.760	0.0000	1.712	Significant*
	Within Groups	72,717.232	483	150.553				
	Total	183,922.060	497					

$\alpha = 0.05$

One-way ANOVA was used to test the null hypothesis that there are no significant differences in the mean scores of the pupils' performances in the instrumental type of test among the schools involved in the study. Table 4 shows that the F statistic (52.760) is greater than the F critical (1.712). Likewise, the p-value (0.0000) is extremely smaller than the 0.05 and 0.01 levels of significance. These results rejected the null hypothesis that there is no significant difference in the mean scores among schools in the instrumental type of test. Hence, there is statistical evidence that at least one school has a different mean score than the other schools. Using Tukey's post hoc test, five groups are generated. Table 5 shows the summary of the groupings.

Table 5. Groupings using Tukey's post hoc method for instrumental type of test

	N	Mean	Groupings				
School #4*	42	82.87	A				
School #1*	51	80.88	A				
School #10*	49	71.03		B			
School #3**	25	61.00		B	C		
School #12**	25	60.89		B	C		
School #5*	38	58.19			C		
School #6*	35	52.06			C	D	
School #2**	35	45.71				D	E
School #14*	32	45.31				D	E
School #8*	40	45.00				D	E
School #7**	41	44.11				D	E

	N	Mean	Groupings	
School #9**	18	42.75	D	E
School #11**	24	42.59	D	E
School #15**	26	39.96		E
School #13**	17	39.71		E

**lowland school; **upland school; means that do not share a letter are significantly different*

As indicated in Table 5, schools #4 and #1 belong to group A and do not share a letter. Hence, the mean scores of schools #1 and #4 are significantly different from the others. Group B contains schools #10, #3 and #12. However, school #10 does not share a letter which means that it differs from the others. Group C contains schools #3, #12, #5 and #6. However, school #5 does not share a letter which means that it differs from the others. Group D comprised seven schools, but all of them shared a letter which means that it does not differ from the others. Group E comprises eight schools, but schools #15 and #13 do not share a letter. Hence, schools #15 and #13 significantly differ from the others. The post hoc test shows that six schools have significantly different mean scores from the others. Therefore, there is sufficient evidence to support that the pupils' performances in the instrumental type of test from the fifteen schools involved in the study vary significantly.

Table 6. Significance of the differences in pupils' performances in relational type of test

Variables	Source of Variation	SS	df	MS	F	P-value	F crit	Significance
Pupils' Performances in Relational Type of Test Among Schools	Between Groups	98,944.247	14	7,067.446	57.568	0.0000	1.712	Significant*
	Within Groups	59,296.571	483	122.767				
	Total	158,240.820	497					

** α = 0.05*

One-way ANOVA was also used to compare the pupils' performances in the relational type of examination to test the null hypothesis that there are no significant differences in the mean scores among the schools involved in the study. Table 6 shows that the F statistic (52.760) is more significant than the F critical (1.712). Likewise, the p-value (0.0000) is extremely smaller than the 0.05 and 0.01 levels of significance. Hence, the null hypothesis is rejected in favor of the alternative hypothesis. It means that there are significant differences in the mean scores among schools in the instrumental type of examination. Hence, there is statistical evidence that at least one school has a different mean score than the other schools. Using Tukey's post hoc test, six groups are generated. Table 7 summarized the results.

Table 7. Groupings using Tukey's post hoc method for relational type of test

	N	Mean	Groupings					
School #4*	42	76.72	A					
School #1*	51	70.86	A					
School #10*	49	63.32		B				
School #5*	38	49.56			C			
School #12**	25	48.22			C	D		
School #6*	35	48.02			C	D		
School #3**	25	45.89			C	D	E	
School #11**	24	42.36			C	D	E	F
School #15**	26	40.92			C	D	E	F
School #13**	17	39.54			C	D	E	F
School #9**	18	37.5				D	E	F
School #2**	35	36.9					E	F
School #7**	41	36.65					E	F
School #14*	32	35.76						F
School #8*	40	34.51						F

**lowland school; **upland school; means that do not share a letter are significantly different*

As shown in Table 7, group A consists of schools #4 and #1, which do not share a letter. Hence, the mean scores for schools #4 and #1 are significantly different from the others. Group B has school #10 only and does not share a letter. Hence, the mean score of school #10 is significantly different from the others. Group C consists of seven schools, but school #5 does not share a letter. Hence, the mean score of school #5 is significantly different from the others. Group D consists of seven schools, but all of them shared letters. Hence, all schools belonging to group D are not significantly different from the others. Group E has seven schools, but all of them also shared letters. Hence, the mean scores of all the schools in group E are not significantly different. Lastly, group F has eight schools, but schools #14 and #8 do not share a letter. Hence, the mean scores of schools #14 and #8 are significantly different from the others. In this post hoc test, six schools have significantly different mean scores from the others. Just like in the instrumental type of test, it can be said that there is sufficient evidence to support that the performances of the pupils in relational type of test from the fifteen schools involved in the study also varies significantly.

CONCLUSIONS

Most of the pupils involved in the study failed in the instrumental type of test and more so in the relational type of test. It indicates that pupils are more exposed to the instrumental approach of teaching than the relational teaching approach. Furthermore, the low scores of the pupils in the instrumental type of test indicate their low or non-mastery of the mathematical concepts and operations introduced by their teachers. Hence, they have more difficulty in the relational type of test. The study also revealed that the pupils' performances in the upland schools are generally deficient compared to some schools in the lowland areas. To note, some schools in the lowland area manifested better performances than the rest of the schools. It implies that the quality of math instruction in some lowland schools is better than the rest of the schools involved in the study. The majority of schools manifest significant differences in the pupils' performance in the instrumental and relational types of tests.

Based on the mean scores, the pupils' performances in the relational type of test is more deficient than the instrumental type of test. Hence, the pupils have more difficulty in the relational type of test. On the differences in the pupils' performances in the instrumental type of test, it is statistically evident that there is a significant variation. Post hoc test reveals six schools with mean scores statistically different from the others in the instrumental type of test. Likewise, it is statistically evident that there is a significant variation in the mean scores of pupils in the relational type of test. Post hoc tests also reveal six schools with mean scores statistically different from the others in the relational type of test. Hence, the analysis of variance and the post hoc test supports the idea that there is indeed a variation in pupils' performances in relational and instrumental types of test.

As mentioned earlier, this variation is a manifestation of the differences in the quality of instruction. However, other factors may have an indirect effect on the pupils' performances, which are not covered in this study. Future studies may identify those factors to have broader background information about the low performance in mathematics. School administrators may assess the teaching practices of the mathematics teachers and provide appropriate training to enhance their teaching competence and desire to teach mathematics effectively.

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