Developing Hots Through Performance Assessment

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Abstract: This study aims at determining the effect of mathematic performance assessment towards students' higher-order thinking skills. This research is classified as an experimental research with non-equivalent control group design involving a sample of 140 high school students in Denpasar, Bali, which was taken by simple random sampling technique. The instrument used to capture data is the HOTs test which has previously been tested for logical validity, empirical validity, and reliability coefficient. The collected data were tested with parametric statistics in the form of t-test after passing the prerequisite test, such as the normality test of data distribution and the variance homogeneity test. The results of this study indicate that there are differences in HOTs result between the students who were given a performance assessment with the students who were given conventional assessments. It is hoped that teachers will reduce the dominance of the use of conventional assessment and gradually move to a more authentic performance assessment.

Index Terms: Mathematic performance assessment, high order thinking skills.

INTRODUCTION

Assessment of student learning outcomes is still dominated by traditional tests (paper and pencil test) in the form of multiple choice, match, right and wrong, and short answers. The multiple choice test with several alternative answers becomes the teacher's primary choice to access students' abilities because it is easy to be prepared, used, and scored. Accessing student learning outcomes with these tests tends to measure low-order thinking skills (LOTs). Therefore, it is necessary to use alternative assessments that are able to trigger high-order thinking skills (HOTs) of students. The term HOTs is used to describe the student's cognitive activities out of the stages of remembering, understanding, and applying, such as at the stage of analyzing, evaluating, and creating [1]. Once students are able to analyze, evaluate a problem, including create another or new work steps, it means that students have applied HOTs, and vice versa. HOTs questions are not difficult, but it requires higher thinking skills in answering them. Not all students have HOTs abilities, so it needs to be learned and taught [2]. Performance assessment is one alternative that can be used to overcome the shortcomings of traditional assessments that are expected to increase student's HOTs. The special feature of performance assessment is "assignments" not "tests". Performance assessments are often referred to authentic assessments, because the performance assignments contain field facts about students' social lives. The changing of conventional assessment with objective tests to be performance assessments has been described as a change from "knowing" to "showing". Performance is different from products or results, because performance presents something can be seen. Performance assessments require the students to present their work performance in solving a problem, not just choose the most fixed answer from the alternatives provided. This assessment can be in the form of project assignments, presentations, solving mathematical problems, conducting research, or playing roles. Research on performance assessments has been carried out and shows positive results for student learning outcomes [3], [4], [5]. Performance assessment is an appropriate instrument to determine student's ability compared to multiple choice tests, because it requires students to use a higher cognitive level (analyze, evaluate, create) and show real performance. In this study, what is meant by assessment of mathematic performance is mathematic performance tasks that require students to demonstrate their performance in completing assignments. The application of performance assessment in learning process give opportunities for students to show their abilities or skills [6], attitudes toward the subject matter [7], and motivate themselves to learn better [8]. Performance assessment is the best understanding that can be in the form of student responses, from the simplest to the most complex. This indicates that the performance assessment requires students to show their performance to know their knowledge. In performance assessment, the student performance, behavior, or interactions in the classroom are assessed. These interactions can be in the form of student interactions with other student, student with teacher, or student interactions with teaching material. Thus, the performance assessment is an assessment that is more concerned with the process without leaving the results. Performance tasks focus on process, products, or a combination of the two [9]. Performance assessment often includes an emphasis on open activities, and there are no correct and objective answers and these assessments assess student's HOTs. For example: there are no right answers when students present in front of the class, or when they make a math project. The open-answer essay test is one of the most common examples of a performance-based assessment of mathematics, and there are many other examples, including artistic production, experiment in science, oral presentation, and using mathematics to solve real-world problems.

METHODOLOGY

This research is a quasi-experimental research with non-equivalent control group design that aims at developing students' higher-order thinking skills through the application of mathematics performance assessment.

Group	Pee -test	Independent Variable	Post-test
Experiment	Y_0	X	Y_1
Control	Y_0	-	Y_1

***Figure 1** Non-Equivalent Control Group Design*

This research was conducted towards high school students in class XI in Denpasar, Bali, involving 140 students as samples which was taken by simple random sampling technique, in the randomized class. The instrument used to capture data is a

$$r_{11} = \left[\frac{n}{n-1}\right]\left[1 - \frac{\sum s_i^2}{s_t^2}\right] \quad (4)$$

mathematics performance assessment and HOTs test that have been tested for validity and reliability coefficient. The validity of the mathematics performance assessment used the approach developed by Lawshe [10] with the formula:

$$CVR = \frac{n_e - N/2}{N/2} \quad (1)$$

Information:
CVR = content validity ratio
n_e = Number of panelists who gave a rating of 3 (important/relevant)
N = Number of panelists

Based on the experts' assessment, it can be obtained that the magnitude of the content validity coefficient of the performance assessment is 0.800. This value is above the minimum stipulation of the content validity coefficient revealed by Lawshe [10], which is a minimum of 0.62 for ten panelists. For the HOTs test, the content validity uses an approach proposed by Gregory [11] which is then substituted into a cross tabulation (2x2) consisting of four columns as shown in Table 1 below.

Table 1 *Cross Tabulation*

		Penilai 1	
		Disagreement (Score 1 – 2)	Agreement (Score 3 - 4)
Penilai 2	Disagreement (Score 1 - 2)	A	B
	Agreement (Score 3 - 4)	C	D

The formula for calculating content validity is:

$$VI/VK = \frac{D}{A+B+C+D} \quad (2)$$

Keterangan:
A = cell that shows disagreement between the two panelist
B dan C = cells that show differences in views between the first and the second panelist
D = cell showing valid agreement between the two panelist

After the analysis process, the HOTs test which consists of five items, has a content validity coefficient of 0.800. The HOTs test has also been empirically tested in the form of item validity test and calculation of the reliability coefficient. The item validity test uses the moment product correlation from Pearson [12] and the results of the 5 items tested are all in the valid category.

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\left(N\sum X^2 - (\sum X)^2\right)\left(N\sum Y^2 - (\sum Y)^2\right)}} \quad (3)$$

While the reliability coefficient was calculated by using alpha Cronbach's coefficient [13] and the result was 0.809, it is in the high category [14].

The collected data are analyzed by using an independent sample t-test, which has previously been tested for prerequisites in the form of data distribution normality test and variance homogeneity test [15].

3 RESULTS AND DISCUSSION

The object of this research is the students' HOTs score as a result of the treatment between the performance assessment and the conventional test. The analyzed data consists of two groups, such as: students' HOTs data in the experimental group and student's HOTs data in the control group. The result recapitulation of the HOTs analysis of the two data groups is presented in Table 2 below.

Table 2 *Summary of HOTs Score between Experimental Group and Control Group*

Statistics

		$HOTS_{Experiment}$	$HOTS_{Control}$
N	Valid	70	70
	Missing	70	70
Mean		74.4571	54.0143
Median		72.0000	54.0000
Mode		70.00	51.00[a]
Std. Deviation		12.11740	10.80860
Variance		146.831	116.826
Range		46.00	61.00
Minimum		52.00	27.00
Maximum		98.00	88.00
Sum		5212.00	3781.00

a. Multiple modes exist. The smallest value is shown

Hypothesis test is carried out after being preceded by conducting analysis prerequisite test, such as: normality test of data distribution and homogeneity test of variance. Each result of the prerequisite test is presented in Table 3 and Table 4 below.

Table 3 *Summary of Normality Test Data Distribution*

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
$HOTS_{Experiment}$	.095	70	.198	.972	70	.111
$HOTS_{control}$	.074	70	.200*	.983	70	.471

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 3 shows that the value of sig. > 0.05 [15] for the two data groups, so both data groups have normal distribution.

Table 4 *Summary of Variance Homogeneity Test*

HOTs

Levene Statistic	df1	df2	Sig.
2.888	1	138	.091

Table 4 shows that the value of sig. > 0.05 [16] or 0.091 > 0.05, so both data groups have the same variance (homogeneous). The analysis of prerequisite tests has been fulfilled so that the hypothesis test using the t-test can be done, and the result is presented in Table 5 below

Table 5 *Summary of Analysis HOTs Student Scores*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conficence Interval of the Difference	
									Lower	Upper
HOTs	Equal variances assumed	2.888	.091	6.411	138	.0001	12.44286	1.94076	8.60539	16.28032
	Equal variances not assumed			6.411	136.236	.0001	12.44286	1.94076	8.60495	16.28079

In Table 5, you can see the sig valueis less than 0.05, that is 0.001 <0.05 for the two- test. This means that Ha is rejected and Ho is accepted, so there are differences in HOTs score of the students who are given mathematics performance assessment and the students who are given conventional assessments in class XI of public high schools in Denpasar, Bali. This finding shows the superiority of performance assessment compared to conventional assessment. By the performance assessment of student learning, it can solve the real problems that are associated with mathematics learning. Through discussion, collaboration, and presentation, students can learn more meaningful. Here are some examples of mathematics performance assessments which are given to the students and also the provided solutions.

ASESMEN KINERJA MATEMATIKA

Satuan Pendidikan	: SMA	Penyusun	: I Wayan Eka Mahendra		
Mata Pelajaran	: Matematika	Tahun Ajaran	: 2019/2020		
Kelas/Semester	: XI/1				
Kompetensi Dasar : 3.1 Unsur-unsur lingkaran		Nomor Asesmen	1	Waktu	10 Menit
Materi: Lingkaran secara analitik		Rumusan Asesmen:			
Indikator 3.1.1 Menyebutkan unsur-unsur lingkaran. 3.1.2 Menggambar unsur-unsur lingkaran.		**Apakah dalam suatu lingkaran tembereng itu sama dengan juring. Jelaskan dan gambarkanlah**			

Figure 2 *First Mathematics Performance Assessment*

This performance assessment gives students a performance assignment about something unusual, because during the learning process, the teacher usually explains the elements of the circle by depicting the segment and sector with different pictures. So when students are given a performance task that is different from normal, they need higher level thinking skills. The provided solutions for the students are as follows.

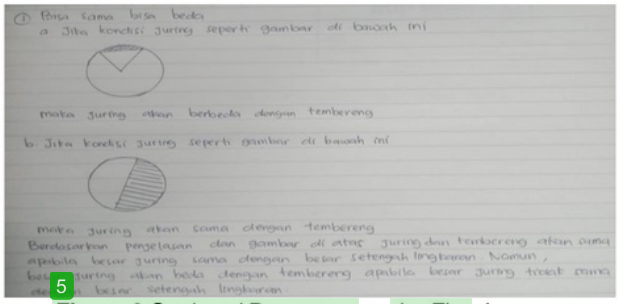

Figure 3 *Students' Responses to the First Assessment*

The second example of performance assessment is as follows.

ASESMEN KINERJA MATEMATIKA

Satuan Pendidikan	: SMA	Penyusun	: I Wayan Eka Mahendra		
Mata Pelajaran	: Matematika	Tahun jaran	: 2019/2020		
Kelas/Semester	: XI/1				
Kompetensi Dasar : 4.3 Menyelesaikan masalah yang terkait dengan lingkaran		Nomor Asesmen	2	Waktu	15 Menit
Materi: Lingkaran secara analitik		Rumusan asesmen:			
Indikator 4.3.4 Menggambar persamaan garis singgung suatu lingkaran. 4.3.5 Memaparkan pengertian dan sifat-sifat dua lingkaran yang berirsan.		**Seorang mekanik ingin memberi penjelasan kepada konsumen tentang gir dan rantai sebuah sepeda. Bantulah mekanik tersebut memberi penjelasan jika gir dan rantai sepeda dikaitkan dengan garis singgung persekutuan dua buah lingkaran dengan terlebih dahulu menggambarnya!**			

Figure 4 *Students' Responses to the Second Assessment*

Performance assessment of mathematics that is given to the students requires not only students' abilities to remember and understand the teaching material, but more than that. This ability is to analyze, evaluate and create according to the ability of HOTs. This happens because the provided performance assessment, in addition to being real, is also something that is rarely even given by the teacher. Students must "think outside of the box" to solve a given problem, so that higher cognitive abilities are needed. For example: a simple question, why is the front gear of a bicycle always bigger than the rear gear? This requires problem analysis skill.

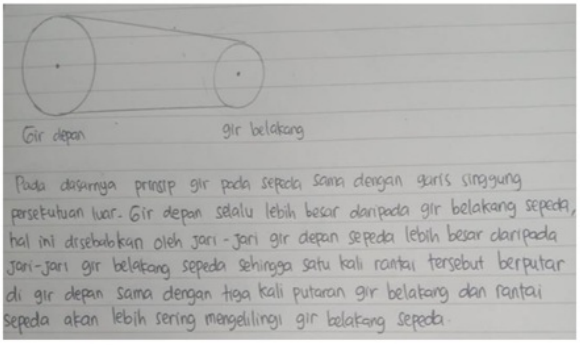

Figure 5 *Students' Responses to the Second Assessment*

Performance assessments given to the students make a positive contribution in developing students' HOTs. Through performance assessment, students feel the given performance assignments are truly meaningful and they immediately know the level of their knowledge of a problem. This contribution can be proven by the number of 23% of student learning outcomes (post test results) are caused by performance assessment [17].

4 CONCLUSION

The result of this study shows that there is an influence of the mathematics performance assessment on the students' high-order thinking skills. Students who are given mathematics performance assessment has an average HOTs score of 75,042, which is much higher than students who are given mathematics conventional assessments of 54,014. By the result of this study, it is expected that teachers can reduce slowly the dominance of the use of conventional assessment in the form of multiple choices and short essay, and use mathematics performance assessment as alternative, so that the students' HOTs could increase.

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