Potency of Performance Test Using Microscopes

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ABSTRACT

This purpose of this study is to show how to carry out a performance test with microscopes used in lower secondary schools and to examine their effectiveness. As a result of this study, we discovered the following:

(1)It is possible to carry out a performance test of a microscope using a video camera; and, by doing so, the teacher can more properly diagnose the ability of students.

(2)Students who like science have a good ability for using microscopes, compared with those students who dislike science.

(3)There is a correlation between the performance test and the Tasknaire Test for measuring microscope skills.

Key Words: performance test, microscope, lower secondary school

I Introduction

An experiment plays an important role in any science class. The use of scientific instruments is necessary for exploring natural phenomenon. Students cannot solve problems without acquiring experimental skills. Some basic experimental skills have been focused on and stressed in recent science textbooks, because experimental skills are considered basic requirements of science.

As a test for experimental skills, the performance test is well known. A performance test is defined as a "test which requires actual operation by each student"[1] or "to check students' achievement of experimental skills by observing experimental activity during lessons"[2]. The value of a performance test is considerable in that teachers can then know the condition of each student and they can reflect on and revise their teaching approach accordingly. On the other hand, there is the disadvantage that performance tests take a long time to prepare and conduct .

There are several articles about research studying the relationship between experimental skills and knowledge. Hamanaka[3] reports that "the achievement scores for skills are different from the knowledge and science achievement scores and that the practical test is more effective than a paper-pencil test in evaluating the experimental skills of filtration." Ishii and Hashimoto[4] report, "there is a close correlation between experimental abilities and written skills. However, it is difficult to say that the students who are superior in written skills can always complete the assembly of an electric circuit correctly and efficiently." Moreover, Suzuki and Tokita[5] studied the relationship between experiments and mental recognition. They reported that "the students' mental recognition about whether they like or dislike science lessons involving observations and experiments depends on their ability and skills." They also reported that the most

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executed experiments in the second field in lower secondary schools were in using a microscope and the most executed experiments in the first field in lower secondary schools were in using a gas burner.

As described above, although there are several articles about experimental skills, there have been few articles written that describe in detail research about performance tests. Particularly, there is only one short article by Kato[6] that focuses on research performance tests with microscopes in lower secondary schools.

Therefore, we chose microscope skills that are typical skills in the second field in lower secondary schools. We studied how to carry out performance tests using microscope skills for lower secondary school students. We also discussed a simple method to do performance tests and studied the relationship between experimental skills and mental recognition.

II Research method

The object of study was a class of lower secondary school students, Grade 1, 35 (Boys 19, Girls 16) in Nara City.

A lesson on microscope skills was given before the performance test. The task for this lesson was "To improve our skills in using a microscope" and the main contents were as follows:

#The students were reminded how to use a microscope based on their experiences at the elementary school level.
#They assembled the microscope.
#They confirmed the names of the parts of the microscope.
#They learned how to calculate multiplying power.
#They learned to pay attention as they used the microscope.
#They observed the preparation for practice (Figure 1) when using the microscope.
#They confirmed how to use the microscope.
#They recorded the results of their observation and reported them to their teacher.

1. Questionnaire

In order to research the attitudes of students to science, a questionnaire survey was conducted on the students in the first lesson after entrance into the school in April. The content was as follows:

"Do you like science? Yes or No"
"Why do you like or dislike science?"

2. Performance test

The performance test with the microscope was held after the microscope lesson based on the observation of plankton.

The performance test was conducted by groups of 3 students for 5 minutes on May 16th. The preparation used is shown in Figure 1. The basis of this preparation refers to the report of Izumi[7]. At first this preparation was drawn to the size shown in Figure 1. Next this preparation was scaled-down to one twentieth of this size using a photocopier. Finally, it was wrapped in laminated film and trimmed for the performance test.

The students observed this preparation from left to right. They confirmed the number of quadrangles and circles and tracked the line from letter S to letter G. The students filled in their answers to the Task (Figure 2). As for the number of quadrangles and circles and the route from S to G, there were many patterns. The teacher delivered some different patterns to the students in each group.

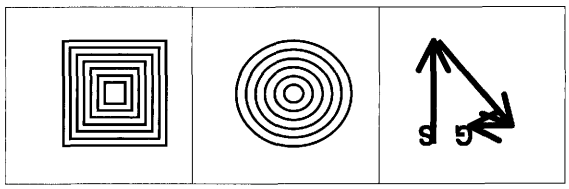

Figure 1 Preparation

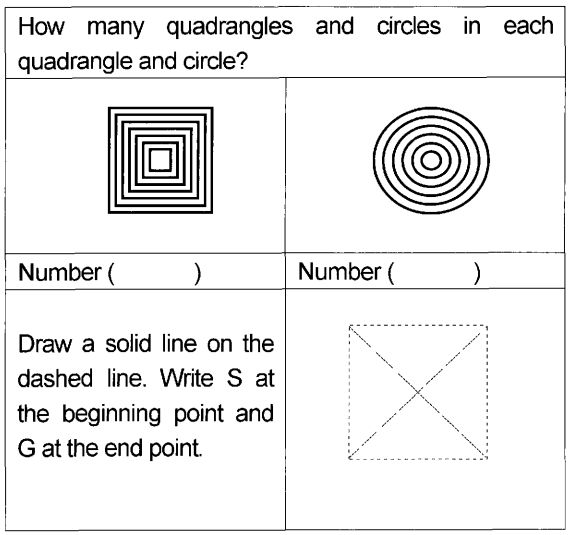

Figure 2 Task

The performance test was videotaped using a tripod for stability. The ideal procedure for microscope usage is as follows:

(1) The students attach the eyepiece.

(2) The students attach the objective lens.

(3) The students adjust the disc diaphragm to the largest hole diameter and arrange the mirror to allow in the greatest amount of light.

(4) The students place the preparation on the stage.

(5) The students bring the preparation as close to the objective lens as possible.

(6) The students focus by slowly raising the lens.

(7) The students detach the objective lens.

(8) The students detach the eyepiece.

In order to mark the Performance, the criteria below were used while watching the videotape. The Task submitted by the students was marked. The correct order and proper operation were from (1) to (8) on the above and the time limit was 5 minutes.

Order
Proper operation
Time out

Ⅲ Results and Discussion

1. Like or dislike of science

The results of the questionnaire are shown in Table 1.

As Table 1 shows, 57% of students (20/35) answered that they liked science. This result is similar to the result on a larger scale for lower secondary school students all over Japan[8]. It is considered that this class is average in terms of the interest shown in science.

2. Performance test

Table 2 shows the results of Performance and Task. In the first row, "L" indicates the students who like science and "D" shows the students who dislike science. The second row shows gender, with "B" for boys and "G" for girls. From (1) to (8) corresponds to the procedure of microscope usage and "Per" means the sum of the performance test. "□" indicates those students who can answer the number of quadrangle and "○" indicates the students who can answer the number of circles. "T" means the students who can track the line and "Task" means the sum of the number of Tasks. Total means the sum of the numbers of Performance and Task.

Table 1. Like and dislike science

	Boys	Girls	Total
Like	12	8	20
Dislike	7	8	15
Total	19	16	35

The points of procedure (7) and (8) are low in the Performance test, as shown in table 2. This is the reason why the students could not finish using the microscope on time. Five minutes for the performance test may have been too short for some students, because they were not familiar with using a microscope. The points of procedure (3), (5) and (6) are also low. As for (3), the students did not have problems in adjusting the mirror to allow in the greatest amount of light. They actually observed the preparation in slightly darkened conditions. As for (5) and (6), the students forgot to bring the preparation as close to the objective as possible and to focus by slowly raising the lens. Though these procedures are very important skills for using the microscope, some students could not acquire them. Some students mistook the order for using a microscope. They did not follow the order for using the microscope. As they wanted to observe the preparation as soon as possible, they may have ignored the correct order for using a microscope. Particularly, the amount of light should be adjusted depending on the multiplication and the lens should be treated carefully so as not to risk getting it dirty. The teachers should teach students these basic skills.

When we confirmed by videotape each student's ability to use a microscope, we found that some students could not understand the order of the microscope usage and they did not care about the important points of using the microscope. Some examples are as follows.

#Some students did not adjust the objective lens to see the preparation correctly.

#Some students did not arrange the mirror to allow in the greatest amount of light.

#Some students placed the preparation on the stage first, then adjusted the disc diaphragm to the largest hole diameter. Next, they arranged the mirror to allow in the greatest amount of light. They operated in the

Table 2 The results of Performance and Task.

Fav	Gender	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	Per	□	○	T	Task	Total
L	G	1	1	1	1	1	1	1	1	8	1	1	1	3	11
L	G	1	1	1	1	1	1	1	1	8	1	1	1	3	11
D	B	1	1	1	1	1	1	1	1	8	1	1	1	3	11
L	B	1	1		1	1	1	1	1	7	1	1	1	3	10
L	B	1	1	1	1	1	1	1	1	8	1	1		2	10
L	B	1	1	1	1			1	1	6	1	1	1	3	9
L	B	1	1	1	1			1	1	6	1	1	1	3	9
L	G	1	1	1	1			1	1	6	1	1	1	3	9
L	B	1				1	1	1	1	5	1	1	1	3	8
D	B	1	1	1	1	1	1			6	1	1		2	8
L	B	1				1	1	1	1	5	1	1	1	3	8
L	G	1	1	1	1	1	1			6		1	1	2	8
L	G	1	1	1	1	1	1			6	1	1		2	8
D	B	1	1	1	1	1	1			6	1	1		2	8
D	B	1	1	1	1	1		1		6	1		1	2	8
L	B	1	1			1	1			4	1	1	1	3	7
L	G	1	1	1	1	1	1			6		1		1	7
D	B	1	1	1	1	1	1			6	1			1	7
L	G	1	1	1	1					4	1	1		2	6
D	G	1				1	1			3	1	1	1	3	6
L	G	1	1		1					3	1	1		2	5
D	G	1						1	1	3		1	1	2	5
L	B	1								1	1	1	1	3	4
L	B	1	1		1					3	1			1	4
D	B	1	1							2	1	1		2	4
D	G	1	1	1	1					4				0	4
D	G	1								1	1	1	1	3	4
D	G	1	1							2	1	1		2	4
D	G	1	1			1	1			4				0	4
L	B	1			1					2		1		1	3
D	G	1								1	1	1		2	3
L	B	1								1		1		1	2
L	B	1								1				0	1
D	B	1								1				0	1
D	G	1								1				0	1
Sum		35	23	16	20	17	16	12	11		25	27	16		
Ave										4.3				1.9	6.2

wrong order.

#Some students tried to focus without moving the objective lens as close to the preparation as possible.

#Some students did not remember the order of procedure for the microscope. They followed the activity of other students.

#Some students used the wrong order of procedure for the microscope.

#Though some students carried out correct procedures, they ran out of time.

As stated above, the teacher could observe the activity of each student carefully. This was an advantage of the performance test. For instance, some students operated in the wrong order. They might have wanted to observe the preparation as soon as possible. Some students did not adjust the objective lens to see the preparation clearly. They may not have understood the mechanism of the microscope. They may not have adjusted the axis of the lens. In other cases, it is guessed that some students just copied the students who were good at using the microscope.

Teachers have never found such points in a usual class. Therefore, it is very important for the teacher to evaluate students' basic science tools skills using a performance test. The teacher can find the weak points of each student and can give the proper advise enabling students to acquire the skills for studying science correctly.

From these results, it seems that the students who like science got higher points, compared with the students who dislike science. Figure 3 shows the results of the Performance test of the students who like science and the students who dislike science. In this graph, it also appears that the students who like science get high points, compared with the students who dislike science.

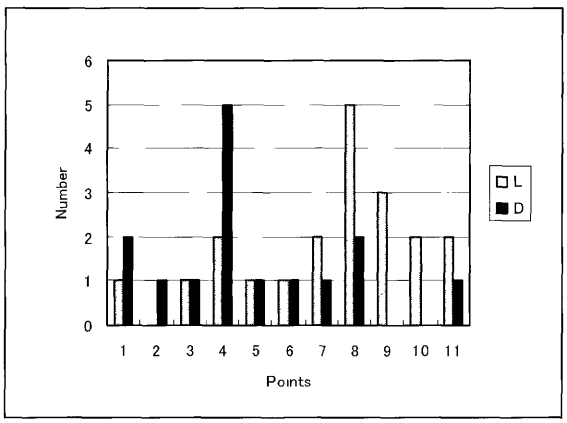

Figure 3 The totals of the Performance and Task
L: The students who like science
D: The students who dislike science

In the questionnaire before performance test, the results were as follows:

"Why do you like or dislike science?"

Like: I like experiments and I enjoy doing experiments.

I can gain new knowledge through doing experiments.

Dislike: It takes a long time for me to do experiments.

I cannot precisely use experimental tools.

According to these results, it was also thought that the students who like science are good at using the microscope and the students who dislike it are not good at using the microscope. In order to show that the difference of the average between the two groups was statistically significant, t-tests were carried out.

Table 3 shows the average and standard deviation and the t-test of points for each student. According to these results, although the students who like science got higher averages in Performance, Task and total, Performance results were not significant, Task and total were significant in the t-test. Therefore, there is a tendency for the students who like science to acquire good skills in using a microscope, compared with the students who dislike science.

When there is a comparison between Performance and Task, it seems that there is a correlation. The correlation coefficient is 0.43 and the t-test is 2.50, which is significant to the 1 % level. Therefore, it is proven that the students who achieve higher points in Task also get higher points in Performance in this study. From this result, we can guess their ability to

Table 3 T-test between the students who like science and the students who dislike science

	Performance		Tasknaire		Total	
	Average	S.D.	Average	S.D.	Average	S.D.
L(20)	4.80	2.27	2.20	0.93	7.00	2.88
D(15)	3.60	2.24	1.60	1.08	5.20	2.69
t-test		1.51^{ns}		1.71*		1.83*

L: Students who like science
D: Students who dislike science
ns: not significant
* : 5% level

use a microscope by this kind of Task without the need to check the videotape of this procedure. This kind of task is also effective for knowing the ability to use the microscope. However, in order to examine the ability to use the microscope carefully, it is necessary to check the videotape.

We hope many teachers will execute the performance test of microscope based on our study.

Ⅳ Conclusion

This study shows that it is possible to carry out a performance test with microscopes used in lower secondary schools by taking videotapes of the procedure. It also shows that teachers can diagnose the ability of students properly. Teachers cannot diagnose each student precisely in a normal classroom setting.

We found the tendency for students who like science to have a good ability for using microscopes, compared with students who dislike science. There is a correlation between the performance test and the Tasknaire test for measuring microscope skills.

This study was conducted based on the relationship between experiments and mental recognition. Further research will consider the relationship between an experimental skill and knowledge. We hope to prove that the higher the experimental skill students have, the more knowledge they have.

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