

# The Effect of Proficiency Testing Participation on Laboratory Performance

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**ABSTRACT:** Data accumulated through the proficiency testing program operated by the Canadian Association for Environmental Analytical Laboratories (CAEAL) was evaluated to determine if proficiency testing participation results in improved laboratory performance. The data shows that, on average, PT performance scores increase over the first few rounds followed by a plateau. This corresponds to a decreased variation in scores. It is suggested that the combination of proficiency testing and conformance to ISO/IEC 17025 through accreditation is the best strategy to ensure consistently high quality analytical results.

## INTRODUCTION

ISO/IEC Guide 43 (1997), ILAC-G13:2000 and CAN-P-1593 (2001) detail the requirements for the development and operation of proficiency testing (PT) schemes and the use of proficiency testing schemes by laboratory accreditation bodies. The premise behind these standards is that participation in a properly designed and coordinated PT program is an essential part of the quality assurance of an analytical laboratory.

The Canadian Association for Environmental Analytical Laboratories (CAEAL) operates a PT program for environmental laboratories. This program supports both accredited laboratories (through a partnership with the Standards Council of Canada) and non-accredited laboratories. Participating laboratories include commercial, industrial, government, and public health labs (~350 participating laboratories). Samples are generally shipped to laboratories twice per year and the labs report on up to 200 parameters. Laboratories are evaluated on each parameter based on consensus statistics (*Standard Operating Procedure for the CAEAL Proficiency Testing Program*: [www.caeal.ca](http://www.caeal.ca)).

An earlier study (Morris and Macey, 2004) indicated that accredited laboratories perform better than non-accredited. This conclusion is not unexpected given that accreditation is dependent on conformance to a quality management standard (ISO/IEC 17025, CAN-P-4D). Although this study also suggested that performance for both accredited and non-accredited laboratories improve over time, too little data was available, over too short a duration, to draw firm conclusions. Although it is logical to

assume that active participation in a PT program will improve the quality (i.e., accuracy and precision) of analytical results, the few studies designed to measure this have typically been restricted to clinical testing (e.g., Hassemer, 1996; Taylor and Fulford, 1981).

The current study uses ten years' worth of data from the CAEAL PT program to examine the effect that participation in a PT program has on laboratory performance.

## METHODS

CAEAL's proficiency testing samples consist of four samples (with different concentrations) shipped to each laboratory twice per year. Reported results are checked for normality, outliers (Grubbs test), and the adjusted mean and standard deviation estimated. Each result is assigned a z score based on the following;

$$Z = \frac{|x - X|}{s}$$

Where: x = reported result  
 X = adjusted mean  
 s = adjusted standard deviation

Points are then assigned for each result using the following criteria;

| Z Score     | Points Assigned |
|-------------|-----------------|
| <1.01       | 5               |
| 1.01 – 2.0  | 4               |
| 2.01 – 3.00 | 2               |
| >3.00       | 0               |

The PT score for the parameter is then calculated from the four samples as;

$$\text{PT Score} = \frac{\text{Total Points}}{4} \times 20$$

All data used in this study were obtained from CAEAL's PT database. The asbestos and the toxicity test groups were excluded due to the different scoring procedures used for these test groups. The following criteria were used to select data for use;

- The first participation for a laboratory/parameter combination had to start after October 1994. This ensured that the first participation event was being captured.
- The laboratory/parameter participation had to be continuous for at least ten consecutive PT rounds following the first event (five years).

This restricted the data set to 84 parameters including inorganics and organics in water, inorganics and organics in soil, inorganics on filters, and microbiological. In total, 29,480 individual parameter scores were used (2,948 laboratory/parameter combinations).

The purpose of this study is to determine if PT participation improves laboratory performance. Thus, regardless of when a laboratory started participation in a parameter, the first score was assigned to study number one. Therefore, study one for any record could be between January 1995 and January 1999.

## RESULTS

Most test groups displayed an obvious improvement over time (e.g., figure 1).

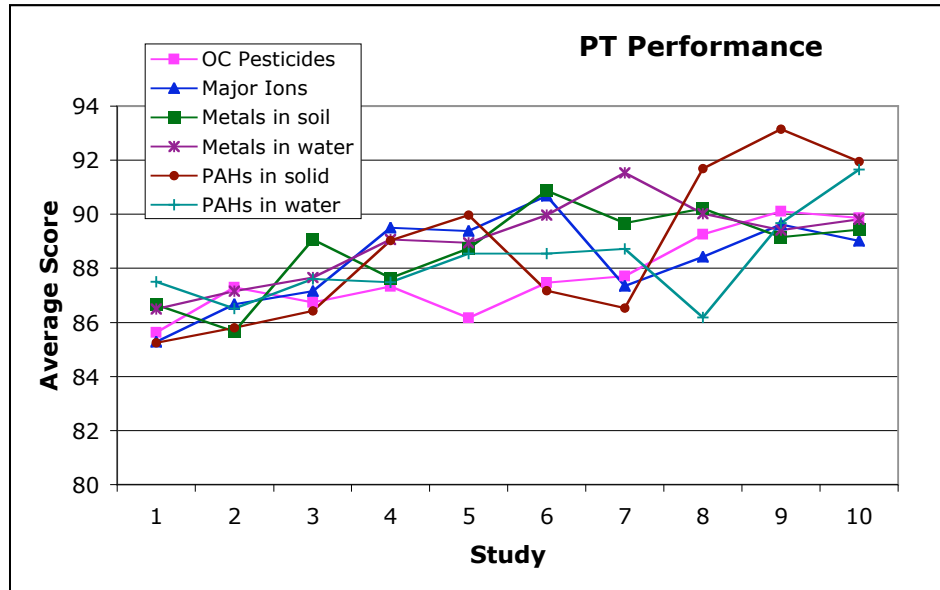


Figure 1. PT test groups where an observable improvement in performance was evident.

Others, however, displayed little change in performance (figure 2).

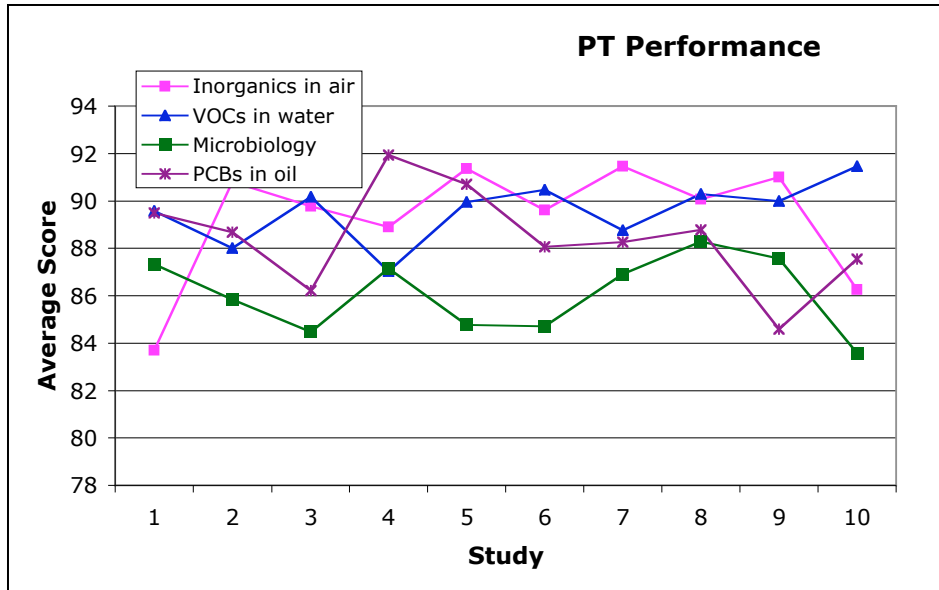


Figure 2. PT test groups where there was no observable change in performance.

When all parameters are combined, including the test groups consisting of 1 to 5 parameters, there is an obvious trend towards improved performance over the first few PT rounds. This is coincident with a decreased variation in scores (figure 3).

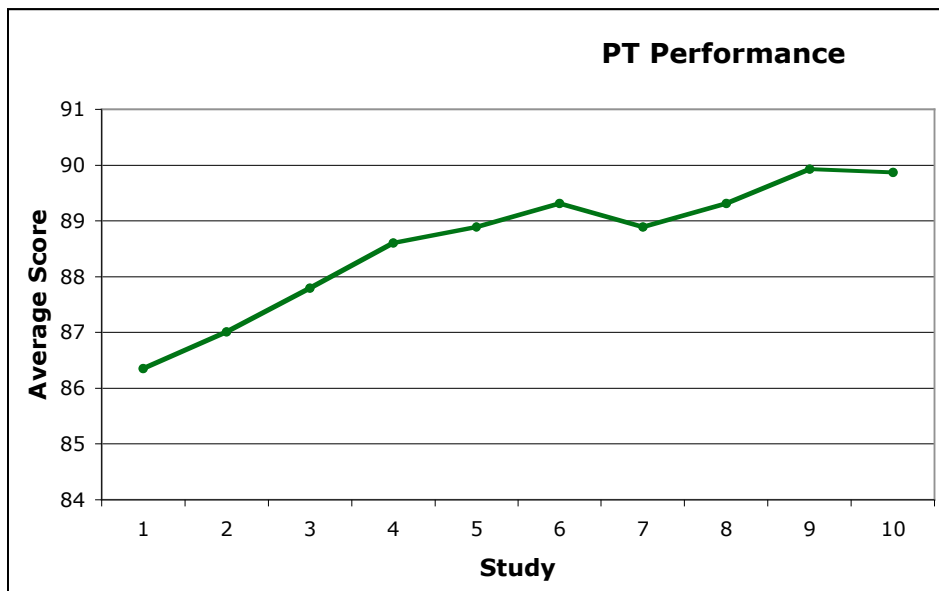


Figure 3. Comparison of average PT score for all parameters combined.

## DISCUSSION

This study demonstrates that, on average, the performance of analytical laboratories, as measured by the CAEAL PT scoring scheme, will improve over the first few participation events (five to six), followed by a plateau. Although this is clearly demonstrated in the combined data, the trend is not as clear on a parameter level basis. Most individual parameters display an improved performance; however, some parameters demonstrate no observable change. The variable response for individual tests is probably related to how well established a procedure is, how rugged the methodology is and whether or not a specific method is widely used (or regulated). There is insufficient information in the CAEAL database to evaluate these possibilities further.

A measured improvement in performance over the first few PT rounds is not unexpected. Due to the cost of PT, the decision to participate in proficiency testing is usually made as part of an overall quality assurance effort, often aimed at the accreditation of the test. Morris and Macey (2004) demonstrated that accredited laboratories perform better in the CAEAL PT program than non-accredited laboratories. Although their evaluation was limited to two studies and five parameters, the data suggested that there was an improvement in average laboratory performance from one study to the next (1997 and 2001), regardless of the labs' accreditation status. The current study substantiates this observation.

This study clearly demonstrates that, on average, there is an improvement in analytical quality over the first few rounds of PT participation. It could be argued that, since PT participation is usually part of an overall quality assurance program, the observed improvement is the result of a combination of efforts, not proficiency testing alone. Although this is certainly true at some level, most other QA related factors would affect all tests in a laboratory concurrently, whereas the design of the current study is such that time zero spans a duration of five years (1995 – 1999). This suggests that the observed trend can be largely attributed to PT participation.

Similar observations have been made for PT participation in the clinical laboratory industry. Taylor and Fulford (1981), using PT performance as a measure, observed that many clinical tests demonstrated an improvement in performance over time and some showed little change. Hassemer (1996) examined clinical PT performance from 1993 to 1996 (11 PT rounds). He observed that the percentage of labs with acceptable scores dropped in 1994, due to the influx of a large number of newly participating laboratories (PT participation became mandatory in 1994), followed by a gradual improvement during the next few rounds. These studies further support the conclusion that PT participation has a direct positive impact on laboratory performance.

Laboratory accreditation and proficiency testing are a powerful combination, providing the tools necessary to effectively manage a laboratory. Conformance to ISO/IEC 17025 (through accreditation) ensures that a laboratory has effective management tools in place. Proficiency testing allows a laboratory to monitor performance, providing a feedback mechanism for identifying areas of concern for investigation and corrective actions.

## **REFERENCES**

**Hassemer, D.** 1996. Does proficiency testing help labs improve? In a word, Yes. Wisconsin State Laboratory of Hygiene, newsletter # 10.

**Morris, A. and D. Macey.** 2004. Laboratory accreditation: Proof of performance for environmental laboratories-2001 study. *Accred. Qual. Assur.* 9:52-54.

**Taylor, R. N. and K. M. Fulford.** 1981. Assessment of laboratory improvement by the centre for disease control diagnostic immunology proficiency testing program. *J. Clin. Microbiol.* 13:356-368.