



# Use, misuse and abuse of Z'-scoring. Guidelines for performance assessment using Z'-score on Proficiency Testing schemes

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## Introduction

A certain number of normalized evaluation methods are described in ISO 13528:2015, so several PT providers are increasingly using the z'-score, instead of the traditional z-score, in which the standard uncertainty of assigned value is taken into account. The laboratory performance evaluated with a z'-score seems to be numerically "better" than the one evaluated using the z-score, simply because of the incremented value of the denominator in z'-score equation.

Since the criteria for using z'-score are not always well understood by participants, it is the role of the PT provider to explain to participants how the evaluation is performed and the reason why z'-score should be calculated.

## Key question

$$Z = \frac{x_i - x_{pt}}{\sigma_{pt}}$$



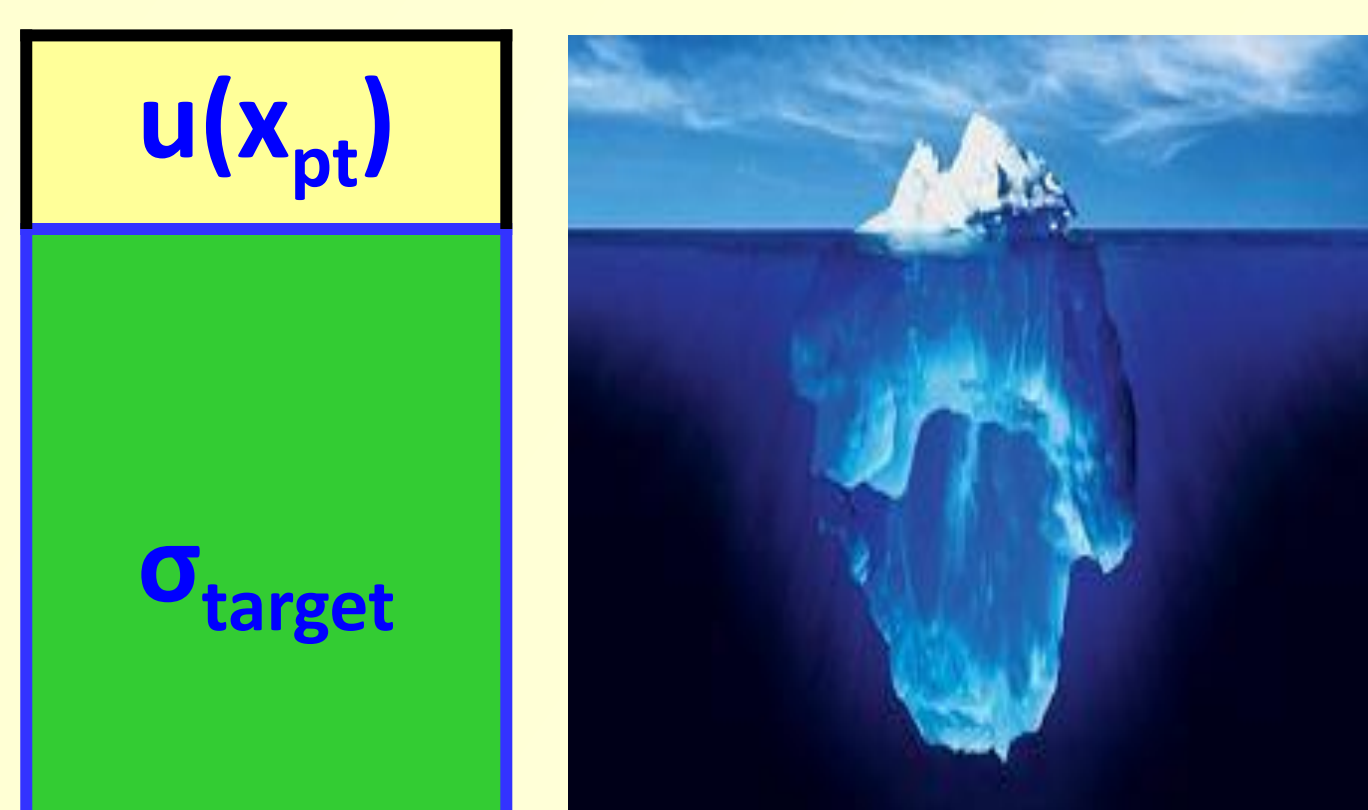
If  $u(x_{pt}) < 0.3 * \sigma_{target}$



If  $u(x_{pt}) > 0.3 * \sigma_{target}$



$$z' = \frac{(x_i - x_{pt})}{\sqrt{\sigma_{pt}^2 + u_{x_{pt}}^2}}$$

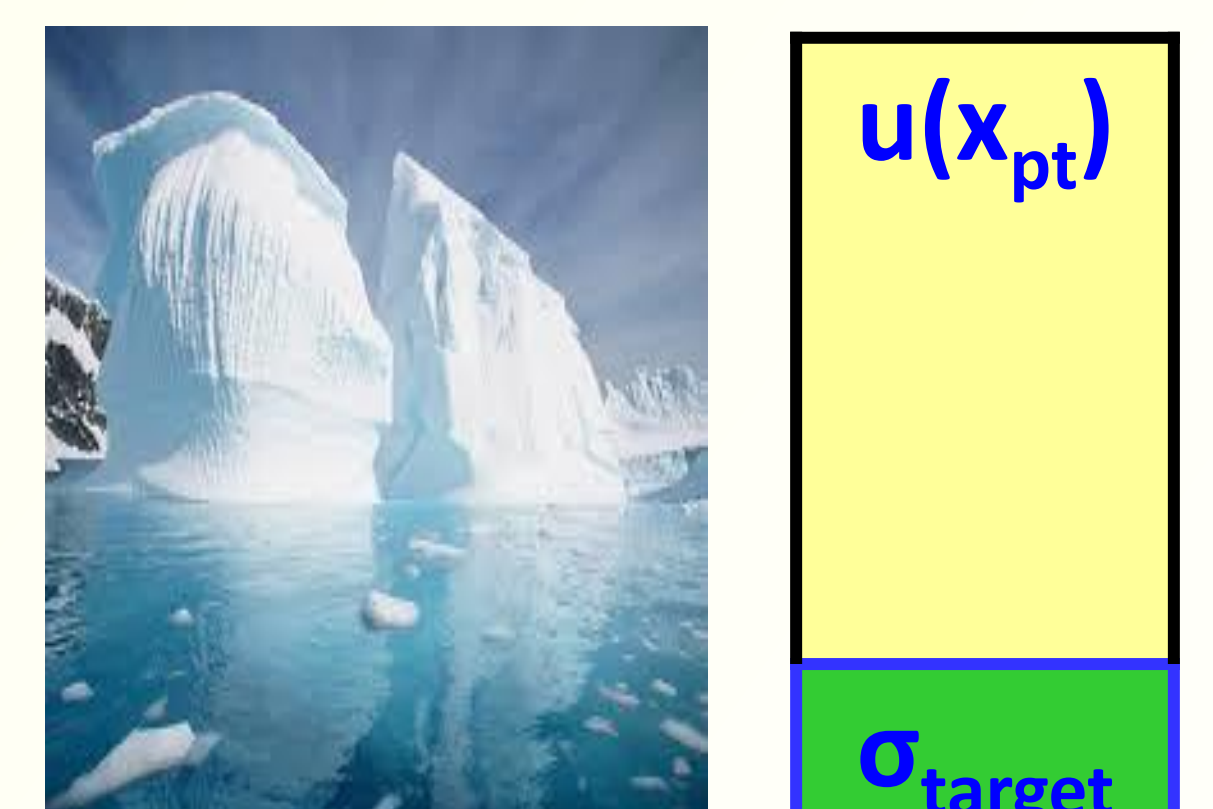


$x_i$  is the result reported by participant;  
 $x_{pt}$  is the assigned value (consensus);  
 $\sigma_{pt}$  is the standard deviation for proficiency assessment;  
 $\sigma_{target}$  is the std. deviation considered as fit for purpose  
 **$u(x_{pt})$  is the standard uncertainty of the assigned value.**

Two possible situations:



If  $0.3 * \sigma_{target} < u(x_{pt}) < 0.7 * \sigma_{target}$



If  $u(x_{pt}) > 0.7 * \sigma_{target}$

Any other scoring ...¿?

Where is the upper limit of  $u(x_{pt})$ ?

Apart from  $\sigma_{pt}^2 / \sigma_{pt}^2 + u(x_{pt})^2$ , the ratio  $z'/z$  depends on the number of results when this number increases.

## PTS examples

$$u(x_{pt}) < 0.3 * \sigma_{target}$$

$$u^2(x_{pt}) / \sigma_{target}^2 < 0,1$$

Laboratory	Z-score	Z'-score
Lab.01	-1,65	-1,24
Lab.02	1,50	1,13
Lab.03	0,55	0,41
Lab.04	0,15	0,12
Lab.05	-0,63	-0,48
Lab.06	0,55	0,41
Lab.07	-0,18	-0,14
Lab.08	-0,24	-0,18
Lab.09	-0,18	-0,14
Lab.10	1,33	1,01
Lab.11	-1,20	-0,90

Table 1

$$0.3 * \sigma_{target} < u(x_{pt}) < 0.7 * \sigma_{target}$$

$$u^2(x_{pt}) / \sigma_{target}^2 = 0,161$$

Laboratory	Z-score	Z'-score
Lab.01	4,35	3,32
Lab.02	1,65	1,26
Lab.03	0,12	0,09
Lab.04	0,82	0,63
Lab.05	-1,06	-0,81
Lab.06	-0,53	-0,40
Lab.07	1,41	1,08
Lab.08	-0,71	-0,54
Lab.09	-12,06	-9,20
Lab.10	-0,12	-0,09
Lab.11	-3,29	-2,51

Table 2

Z'-Score  
informative

## Guidelines and Conclusions

### For PT Providers

- ✓ Estimate uncertainty (assigned value) by other ways
- ✓ Determine assigned value but no by consensus
- ✓ Scoring for informative purpose only
- ✓ No calculate proficiency assessment
- ✓ Advise and clarify labs the reasons for use z'-scoring

$$I = u^2(x_{pt}) / \sigma_{target}^2$$

If  $I < 0.1$ , issue unqualified z-scores  
If  $0.1 < I < 0.5$ , issue qualified z-scores  
(such as "provisional z-scores")  
If  $I > 0.5$ , do not issue z-scores.

IUPAC 2006 Harmonized Protocol



### For Laboratories

- ✓ Read "all" proficiency test report
- ✓ Ask for uncertainty assigned value to PT provider
- ✓ After this, check if  $u(x_{pt}) < 0,3 \sigma_{target}$  or not
- ✓ Check number of laboratories on PT
- ✓ Understand correctly your z'-scoring

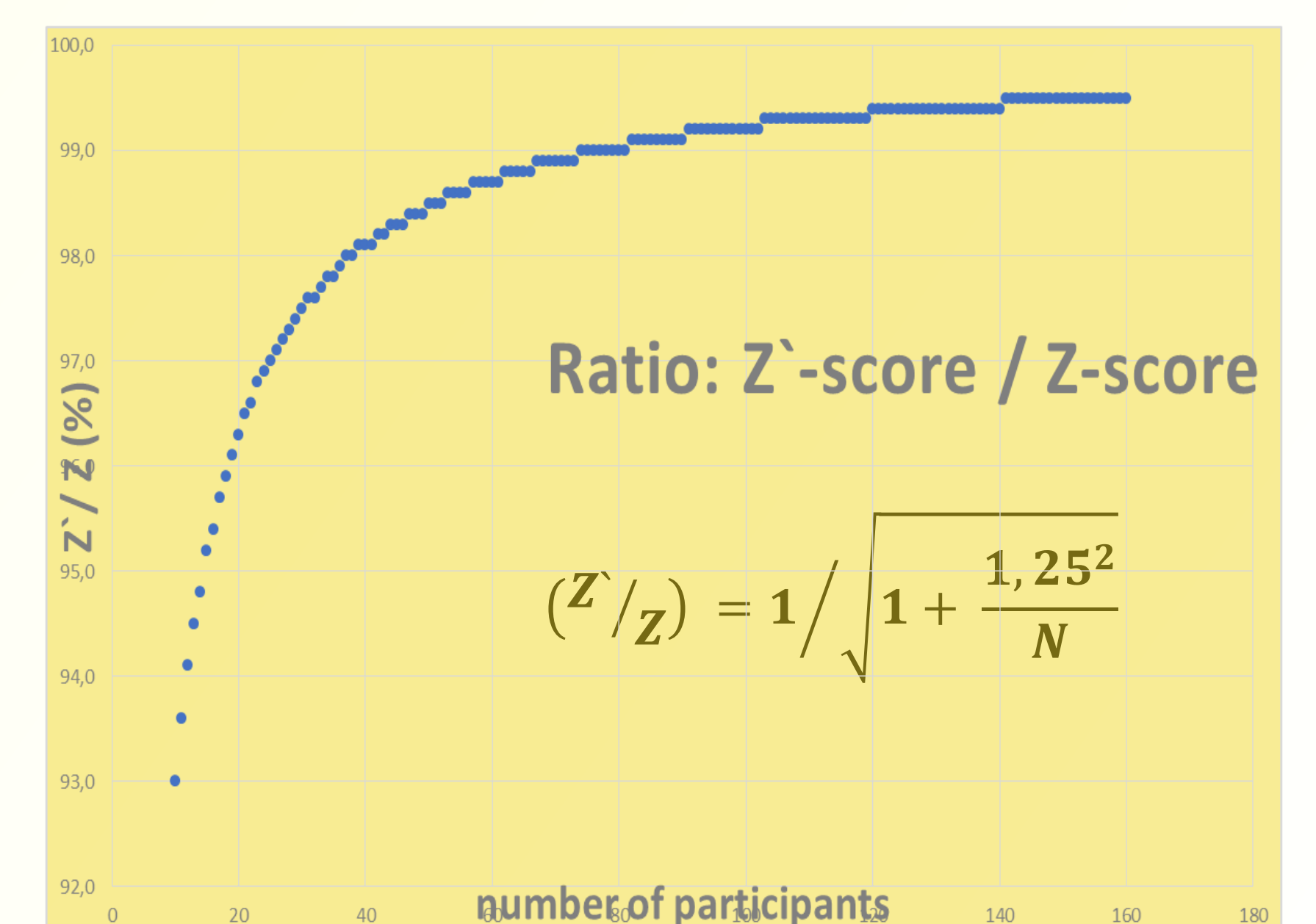


Figure 1.

Some guidelines for good practice of use and understanding z'-scoring by PT providers and laboratories are shown. Furthermore, these proposed rules should be verified regularly, as well as the definition of practical conditions of application over different PT schemes where **uncertainty of assigned value is a key question.**

### References:

ISO 13528:2015. "Statistical methods for use in proficiency testing by interlaboratory comparisons".

EURACHEM Guide (2011); "Selection, use and interpretation of PT Schemes"

P. Rosario, J.Luis Martínez Pareja y J. Silván "Comparison of different statistical methods for evaluation of proficiency test data". Accreditation and Quality Assurance. Accred. Qual Assur. 13:493-499 (2008)