

ISO 13528:2022-08 (E)

Statistical methods for use in proficiency testing by interlaboratory comparison

Contents		Page
	Foreword	v
0		
	Introduction	vi
1	Scope	1
2	Normative references	1
3	Terms and definitions	1
4	General principles	4
	4.1 General requirements for statistical methods.....	4
	4.2 Basic model.....	5
	4.3 General approaches for the evaluation of performance.....	5
5	Guidelines for the statistical design of proficiency testing schemes	6
	5.1 Introduction to the statistical design of proficiency testing schemes.....	6
	5.2 Basis of a statistical design.....	6
	5.3 Considerations for the statistical distribution of results.....	7
	5.4 Considerations for small numbers of participants.....	8
	5.5 Guidelines for choosing the reporting format.....	8
	5.5.1 General requirements for reporting format.....	8
	5.5.2 Reporting of replicate measurements.....	9
	5.5.3 Reporting of 'less than' or 'greater than' a limit (censored data).....	9
	5.5.4 Number of significant digits.....	9
6	Guidelines for the initial review of proficiency testing items and results	10
	6.1 Homogeneity and stability of proficiency test items.....	10
	6.2 Considerations for different measurement methods.....	11
	6.3 Blunder removal.....	11
	6.4 Visual review of data.....	12
	6.5 Robust statistical methods.....	12
	6.6 Outlier techniques for individual results.....	13
7	Determination of the assigned value and its standard uncertainty	14
	7.1 Choice of method of determining the assigned value.....	14
	7.2 Determining the uncertainty of the assigned value.....	14
	7.3 Formulation.....	15
	7.4 Certified reference material.....	16
	7.5 Results from one laboratory.....	16
	7.6 Consensus value from expert laboratories.....	17
	7.7 Consensus value from participant results.....	18
	7.8 Comparison of the assigned value with an independent reference value.....	19
8	Determination of criteria for evaluation of performance	20
	8.1 Approaches for determining evaluation criteria.....	20
	8.2 By perception of experts.....	21
	8.3 By experience from previous rounds of a proficiency testing scheme.....	21
	8.4 By use of a general model.....	21
	8.5 Using the repeatability and reproducibility standard deviations from a previous collaborative study of precision of a measurement method.....	22
	8.6 From data obtained in the same round of a proficiency testing scheme.....	22
	8.7 Monitoring interlaboratory agreement.....	23
9	Calculation of performance statistics	24
	9.1 General considerations for determining performance.....	24
	9.2 Limiting the uncertainty of the assigned value.....	24
	9.3 Estimates of deviation (measurement error).....	25
	9.4 z scores.....	26
	9.5 z' scores.....	27

9.6	Zeta scores (ζ)	28
9.7	E_n scores	29
9.8	Evaluation of participant uncertainties in testing	30
9.9	Combined performance scores	31
10	Graphical methods for describing performance scores	32
10.1	Application of graphical methods	32
10.2	Histograms of results or performance scores	32
10.3	Kernel density plots	33
10.4	Bar-plots of standardized performance scores	34
10.5	Youden plot	34
10.6	Plots of repeatability standard deviations	35
10.7	Split samples	36
10.8	Graphical methods for combining performance scores over several rounds of a proficiency testing scheme	37
11	Design and analysis of qualitative proficiency testing schemes (including nominal and ordinal properties)	38
11.1	Types of qualitative data	38
11.2	Statistical design	38
11.3	Assigned values for qualitative proficiency testing schemes	39
11.4	Performance evaluation and scoring for qualitative proficiency testing schemes	40
	Annex A (normative) Symbols	42
	Annex B (informative) Homogeneity and stability of proficiency test items	44
	Annex C (informative) Robust analysis	52
	Annex D (informative) Additional guidance on statistical procedures	63
	Annex E (informative) Illustrative examples	68
	Annex F (Informative) Example of computer code for plotting and resampling analysis (“bootstrapping”) of PT results	91
	Bibliography	92