DBL Example:
Measurement quality assurance
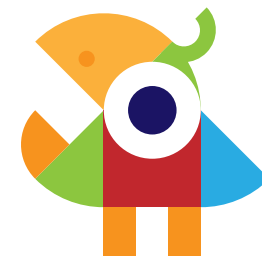
University of Zaragoza

01.

Design Criteria of the DBL Activity

# Lecture context

Subject	• Manufacturing Technologies
Degree	• Industrial Technologies Engineering
Duration	• 3h
Modality	• In a computer room
Students	• 10-13 students
Working groups	• Groups of 3 people

Intended Learning Outcomes (ILOs)

- Learning how to perform a calibration procedure.

- Learning how to estimate the measuring uncertainty.

- Learning how to perform a repeatability and reproducibility (R&R) study for measuring systems.

- Proposing solutions for improving the measuring uncertainty.

- Proposing solutions for improving the repeatability and the reproducibility.
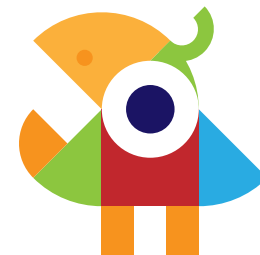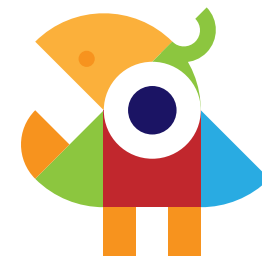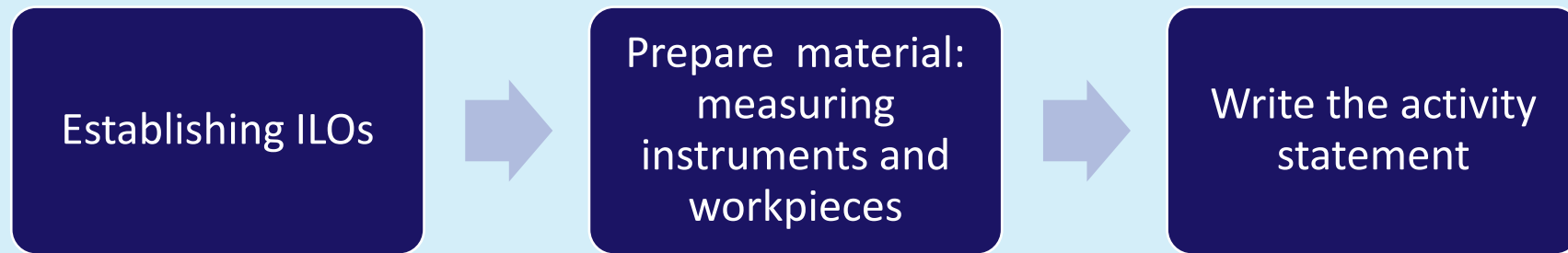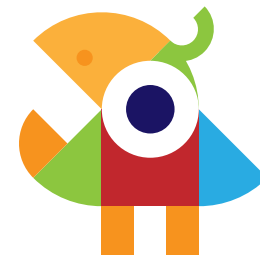
02.

Activity Design

Course scripting

Establishing ILOs → Prepare material: measuring instruments and workpieces → Write the activity statement
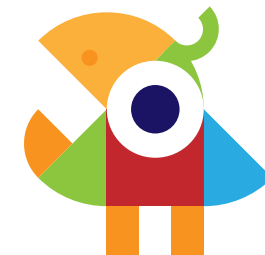
Activity statement

The teacher proposes students the following scenario: the group of students are the workers of a workshop where they manufacture parts. The customer has asked them to verify that the parts comply with the design tolerances, and they have to decide if the measuring instruments that they have are capable of verifying those tolerances. To do that, first they will have to calibrate the instrument, then, calculate its measuring uncertainty, and, finally, perform a R&R study. Once they analyze the resulting dataset, they will have to propose solutions to improve the measuring procedure.

Lesson Flow

Presenting the DBL activity:

- Activity statement
- Work to be done by the students
- Description of the measuring system and the workpieces
- Description of the results expected

Developing the activity

- The students work autonomously: they perform the measurements and write the data in an Excel sheet
- In the Excel sheet they work with the data to obtain results
- The teacher provides guidance when needed

Analysing results and proposing solutions

- The students analyse the dataset obtained, and they extract results.
- In view of the results, the students propose solutions for improving the measuring quality.
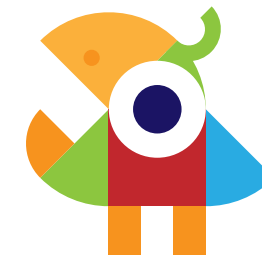
Lesson Flow

Dataset generated by the students during the R&R study:

Measured workpieces
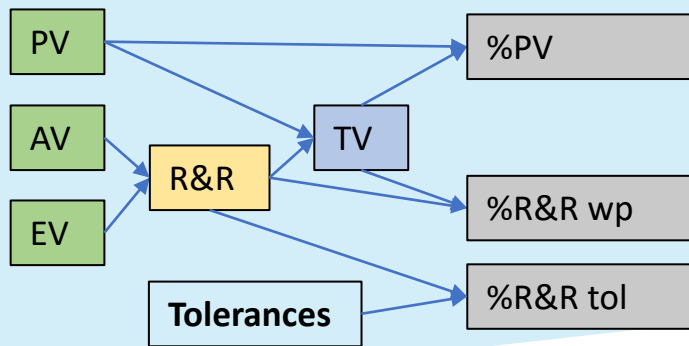
List of workers

Measure-ents of the same workpiece

		HOJA DE DATOS DEL ESTUDIO R&R										
Operario					Pieza						Medias	
Intento	1	2	3	4	5	6	7	8	9	10		
A 1	24,06	24,03	24,06	23,97	24,00	24,04	24,08	24,02	24,04	24,08		
2	24,06	24,02	24,06	23,98	24,01	24,05	24,07	24,02	24,04	24,08		
3	24,06	24,03	24,06	23,98	24,00	24,04	24,08	24,02	24,06	24,07		
Media	24,06	24,03	24,06	23,98	24,00	24,04	24,08	24,02	24,05	24,08	Xa=	24,04
Rango	0,00	0,01	0,00	0,01	0,01	0,01	0,01	0,00	0,02	0,01	Ra=	0,01
Operario					Pieza						Medias	
Intento	1	2	3	4	5	6	7	8	9	10		
B 1	24,06	24,03	24,06	23,97	24,00	24,04	24,08	24,03	24,04	24,08		
2	24,05	24,03	24,06	23,97	24,00	24,05	24,08	24,02	24,04	24,08		
3	24,06	24,03	24,05	23,97	24,00	24,05	24,07	24,02	24,05	24,08		
Media	24,06	24,03	24,06	23,97	24,00	24,05	24,08	24,02	24,04	24,08	Xb=	24,04
Rango	0,01	0,00	0,01	0,00	0,00	0,01	0,01	0,01	0,01	0,00	Rb=	0,006
Operario					Pieza						Medias	
Intento	1	2	3	4	5	6	7	8	9	10		
C 1	24,06	24,03	24,06	23,97	24,00	24,04	24,08	24,03	24,03	24,08		
2	24,06	24,02	24,05	23,98	24,01	24,05	24,09	24,02	24,04	24,07		
3	24,06	24,02	24,06	23,97	24,01	24,04	24,09	24,02	24,04	24,08		
Media	24,06	24,02	24,06	23,97	24,01	24,04	24,09	24,02	24,04	24,08	Xc=	24,04
Rango	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	Rc=	0,009
Pieza												
M Xp	24,06	24,03	24,06	23,97	24,00	24,04	24,08	24,02	24,04	24,08	Rp=	0,11

(Ra(	0,008	)+ Rb (	0,006	)+ Rc (	0,009	))/ Nº de Operarios(		3	))		Rt=	0,008

		(Max X(	24,04	)	-	Min X(	24,04	))			XDiff=	7E-04

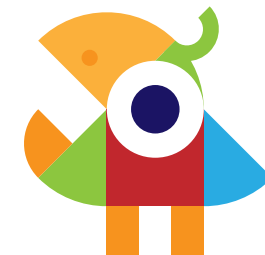|								Intentos	D4			
	(Rt(	0,008	) xD4 (	2,58	))			2	3,27		UCLi=	0,02
								3	2,58			

Lesson Flow

Analysis of results of the R&R study:

- Repeated measurements of the same workpiece→ Measuring system repeateability (EV)
- Measurements by several workers → Reproducibility (AV)
- Measurement of sevrral workpieces →Workpieces variation (PV)
- Total measured variation (TV)

03.

Evaluation and optimization of the learning process

Evaluation and optimization of the learning process

Course scripting evaluation

Course flow evaluation

Students' performance evaluation

Improvement of the activity