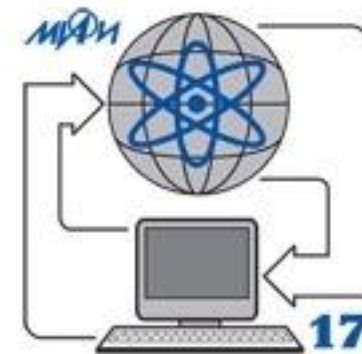




Department of  
Computer Science and  
Control Processes



# The analysis of the educational measurement results, and its providing as “software-as-a-service” solution in eLearning

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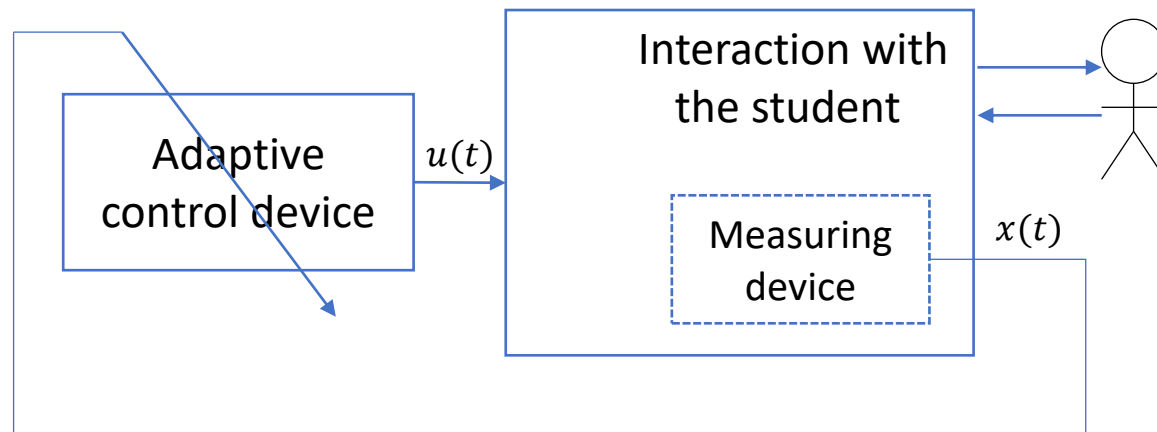
O.N. Gustun

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Moscow, 2021

# eLEARNING PROCESS

## The adaptive informational and educational environment



- Assistance in the educator's professional activities.
- Increasing the effectiveness of learning.
- Individualization of the learning path.

### Adaptive control:

- educational measurements,
- feedback principle,
- structural and parametric variability.

### Assessment tools quality:

- reliability,
- discriminatory power,
- homogeneity.

# RELIABILITY COEFFICIENT

**Reliability** – internal consistency of the test task.

**Coefficient Alpha:**

$$\alpha = \frac{k}{k - 1} \left( 1 - \frac{\sum \sigma_i^2}{\sigma_x^2} \right)$$

$k$  – the number of items on the test;

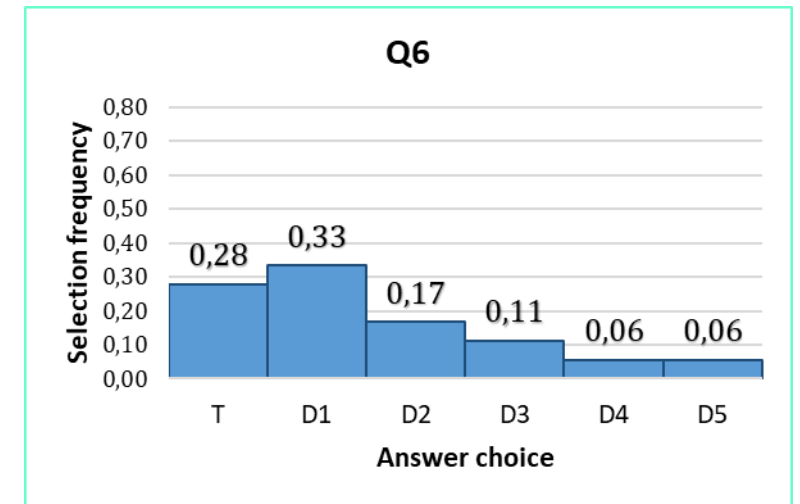
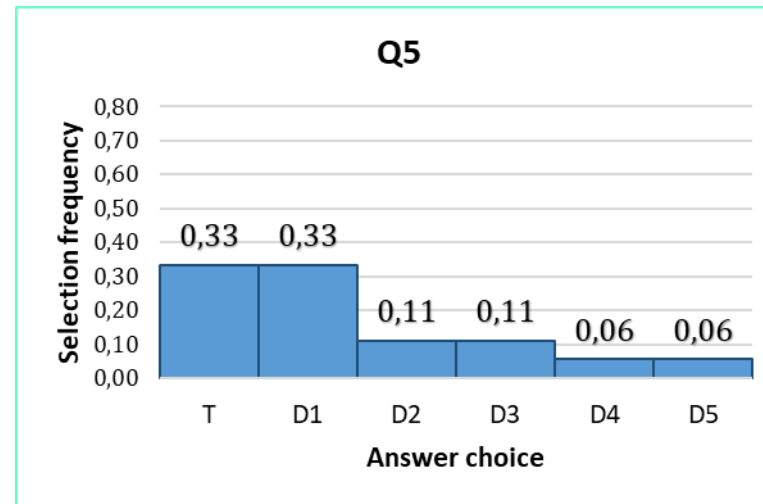
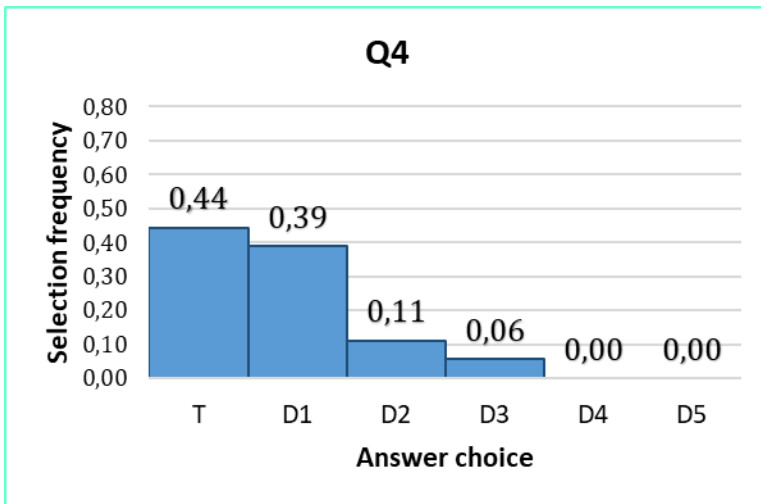
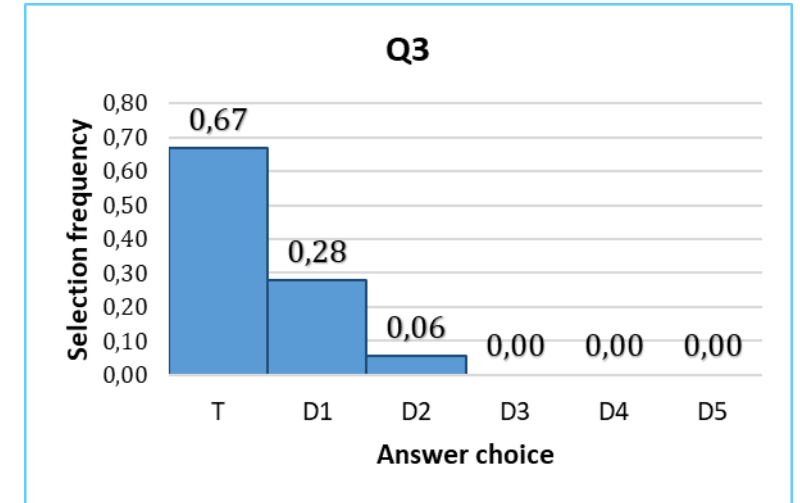
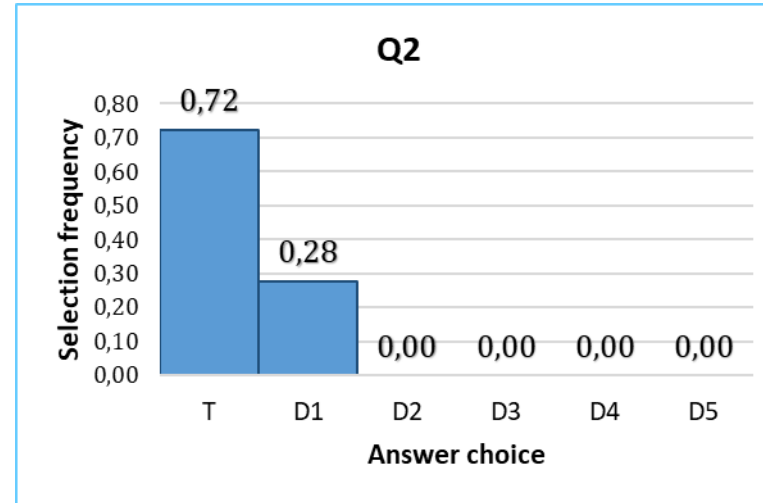
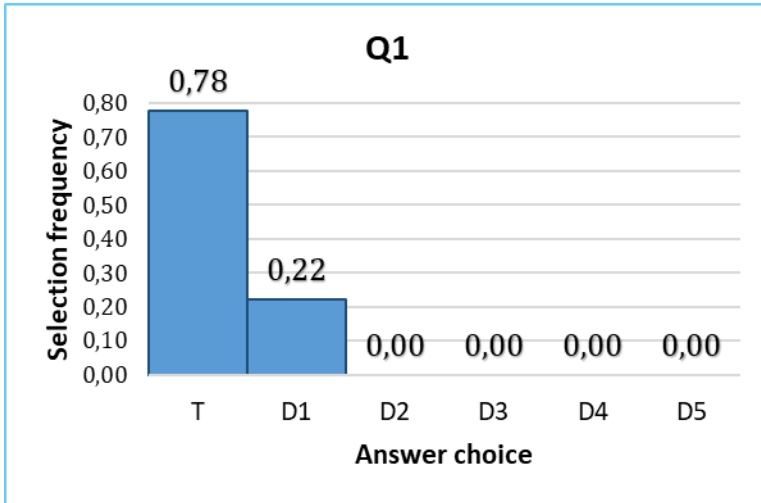
$\sigma_i^2$  – the variance of item  $i$ ;

$\sigma_x^2$  – the total test variance.

No.	Student	Q1	Q2	Q3	Q4	Q5	Q6	Total:
1.	A	1	1	1	1	1	1	6
2.	B	1	1	1	1	1	1	6
3.	C	1	1	1	1	1	1	6
4.	D	1	1	1	1	1	1	6
5.	E	1	1	1	1	1	1	6
6.	F	1	1	1	1	1	0	5
7.	G	1	1	1	1	0	0	4
8.	H	1	1	1	1	0	0	4
9.	I	1	1	1	0	0	0	3
10.	J	1	1	1	0	0	0	3
11.	K	1	1	1	0	0	0	3
12.	L	1	1	1	0	0	0	3
13.	M	1	1	0	0	0	0	2
14.	N	1	0	0	0	0	0	1
15.	O	0	0	0	0	0	0	0
16.	P	0	0	0	0	0	0	0
17.	Q	0	0	0	0	0	0	0
18.	R	0	0	0	0	0	0	0
		<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Q5</b>	<b>Q6</b>	
	$p_i$	0,78	0,72	0,67	0,44	0,33	0,28	
	$\sigma_i$	0,43	0,46	0,49	0,51	0,49	0,46	
	$\sigma_x$	2,32						

$$\alpha = 0,9$$

# DISCRIMINATORY POWER



## DISCRIMINATORY POWER

The index of how effectively the item discriminates between examinees who are relatively high on the criterion of interest and those who are relatively low.

$$D = p_u - p_l$$

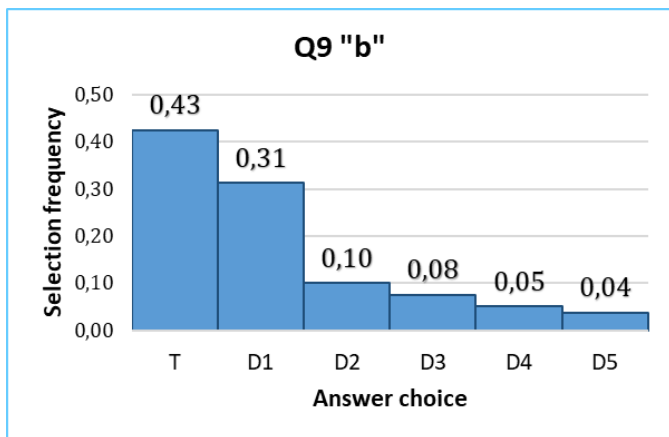
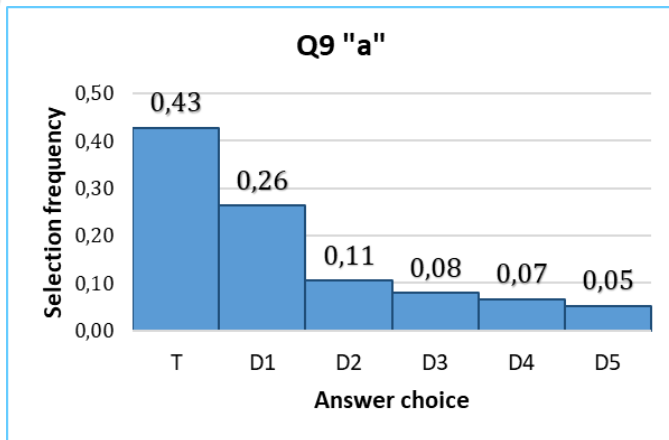
$p_u$  – the proportion in the upper group who answered the item correctly;

$p_l$  – the proportion in the lower group who answered the item correctly.

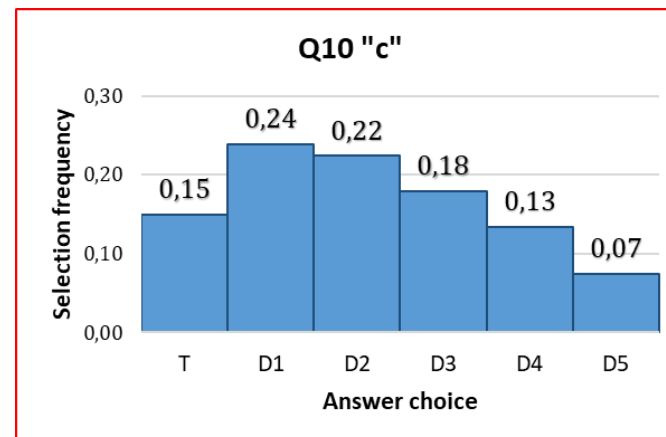
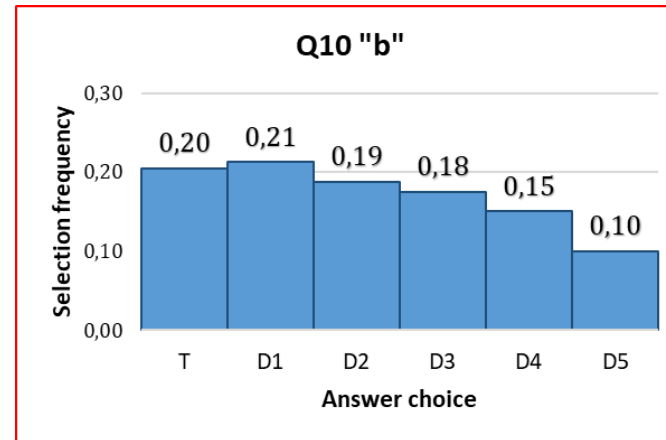
№	Student	Q1	Q2	Q3	Q4	Q5	Q6	Всего:
1.	A	1	1	1	1	1	1	6
2.	B	1	1	1	1	1	1	6
3.	C	1	1	1	1	1	1	6
4.	D	1	1	1	1	1	1	6
5.	E	1	1	1	1	1	1	6
6.	F	1	1	1	1	1	0	5
7.	G	1	1	1	1	0	0	4
8.	H	1	1	1	1	0	0	4
9.	I	1	1	1	0	0	0	3
10.	J	1	1	1	0	0	0	3
11.	K	1	1	1	0	0	0	3
12.	L	1	1	1	0	0	0	3
13.	M	1	1	0	0	0	0	2
14.	N	1	0	0	0	0	0	1
15.	O	0	0	0	0	0	0	0
16.	P	0	0	0	0	0	0	0
17.	Q	0	0	0	0	0	0	0
18.	R	0	0	0	0	0	0	0
		<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Q5</b>	<b>Q6</b>	
	$D_i$	0,44	0,56	0,67	0,89	0,67	0,56	

## COMPARATIVE ANALYSIS

$$D = 0,49$$



$$D = 0,23$$



1. If  $D \geq 0,40$ , the item is functioning quite satisfactorily.
2. If  $0,30 \leq D \leq 0,39$ , little or no revision is required.
3. If  $0,20 \leq D \leq 0,29$ , the item is marginal and needs revision.
4. If  $D \leq 0,19$ , the item should be eliminated or completely revised.

## HOMOGENEITY ASSESSMENT

$H_0: p_1 = p_2$  with an alternative  $H_1: p_1 \neq p_2$ .

**Statistical criterion:**

$$Q = \frac{p_1 - p_2}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$$

$p_1, p_2$  – frequency of a correctly selected response;

$n_1, n_2$  – total number of students.

**Criterion of homogeneity:**

$$|Q| \leq K,$$

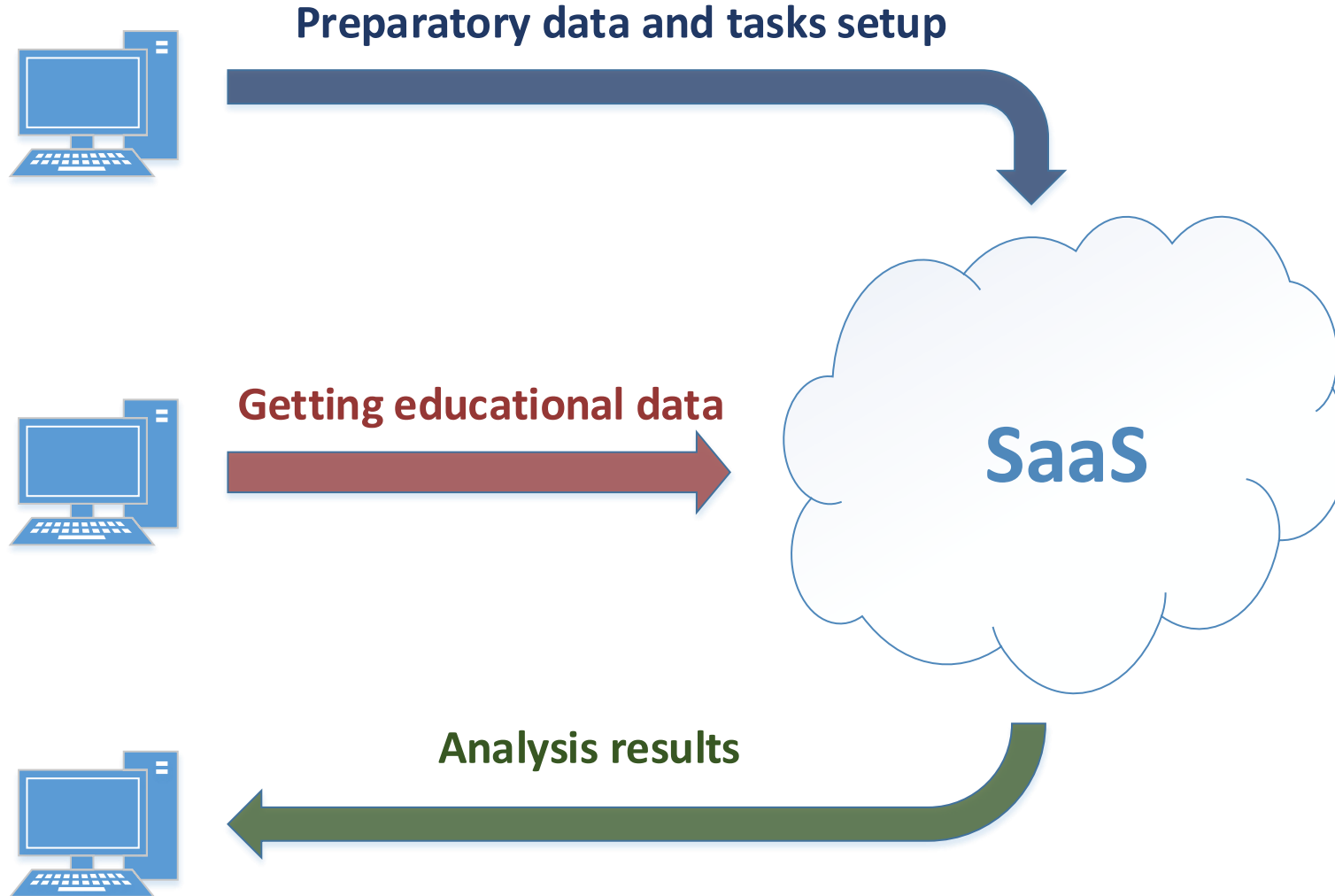
$K = K(\alpha) = \Phi^{-1}\left(\frac{1+\alpha}{2}\right)$  – function inverse to the standard normal distribution function. With  $\alpha = 0,05$  and  $K = 1,96$ .

## HOMOGENEITY ASSESSMENT

Question ID	Pairs of question wording options	$ Q $	$K$	Criterion of homogeneity:	Difficulty, $p$	Recommendations
010302 (a, b, c, d)	a – b	1,12	1,96	done	$p_{abcd} = 0,38$	
	a – c	0,81		done		
	a – d	0,82		done		
	b – c	0,33		done		
	b – d	0,39		done		
	d – c	0,04		done		
010304 (a, b, c, d)	a – b	1,22	1,96	done	$p_{acd} = 0,59$	Option {b} should be changed or deleted altogether.
	a – c	1,07		done		
	a – d	0,17		done		
	b – c	2,38		error		
	b – d	1,42		done		
	d – c	0,91		done		
010903 (a, b, c, d)	a – b	2,04	1,96	error	$p_{ac} = 0,35$ $p_{bd} = 0,56$	The options should be divided into {a, c} and {b, d}.
	a – c	0,21		done		
	a – d	3,47		error		
	b – c	1,9		done		
	b – d	1,42		done		
	d – c	3,38		error		



# Software-as-a-Service



# Software-as-a-Service

## Preparatory stage:

- courses
  - topics
    - tasks (with variants)
- [ students ]
  - profile
  - groups

## Getting educational data:

- student ID
- task/item ID
- answer ID
- time

## Tasks setup:

- type
- structure (items)
- parameters
- conditions
- answers

## Analysis results:

- task ID
- difficulty
- variance-covariance matrix
- reliability
- discriminatory power
- homogeneity (for each variants)
- validity



***Thank you for your  
attention!***

