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# **ACQUISITION OF STUDENT SCIENTIFIC INQUIRY SKILLS: CENTRALISED EXAMINATION RESULTS IN CHEMISTRY**

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## STUDENT'S SCIENTIFIC INQUIRY

<b>Planning and Projecting</b>	The student:	identifies and formulates research problem	<b>Collaboration in groups, pairs</b>
		identifies(chooses) and groups values and marks	
		formulates hypothesis	
		choose appropriate working materials, substances	
		plans working process	
<b>Exspermental Action</b>	The student:	uses working materials and substances	
		observes, measures and registers data	
		processes data	
<b>Result Analysis, Evaluation and Presentation</b>	The student:	analyses, evaluates results, makes conclusions	
		presents work results	

## **Research questions**

- To what extent are the centralised examination inquiry skills measured according to the standard outcomes?
- What information on how students have mastered the inquiry skills in chemistry is available from the CE results for the period of 2011-2015?
- Does measuring the inquiry skills using inquiry-based laboratory work and inquiry tasks demonstrate similar achievements?

## **Research methods**

Over the period from 2011 to 2015:

- Analysis of the CE examination papers.
- Analysis of the student CE work.
- Analysis of the ILW records submitted by schools.
- Analysis of the CE results.

## Table 4. Fragment of task 3\_3 of the CE in 2011

Read the text and do what is required.

*Milk is a mixture containing many different substances, including, protein, amino acids and lactic acid. The concentration of amino acids varies in fresh milk and cultured products because it is gradually changing during the acidification process.*

Formulate the research problem using the information provided in the scenario!

Formulate the hypothesis, including the independent variable, dependent variable and justification! Plan an experiment for proving your hypothesis in a laboratory!

# Example of the Assessment Criteria for the Inquiry Skill "Plans the procedure" (NCE, 2015)

Level	<b>Complete</b> 2 points	<b>Partial</b> 1 point	<b>No</b> 0 points
<b>Assessment Criteria</b>	Describes the sequence of actions for identifying variables and/or features, using the chosen materials and equipment for the purpose of obtaining sufficient and reliable data. Envisages meeting the safety rules.	Incompletely describes the sequence of actions for obtaining sufficient and reliable data, identifying the materials and equipment <b>or</b> does not envisage meeting any safety rules.	Writes separate steps of the procedure plan or the described procedure plan is unsuitable for obtaining any data.

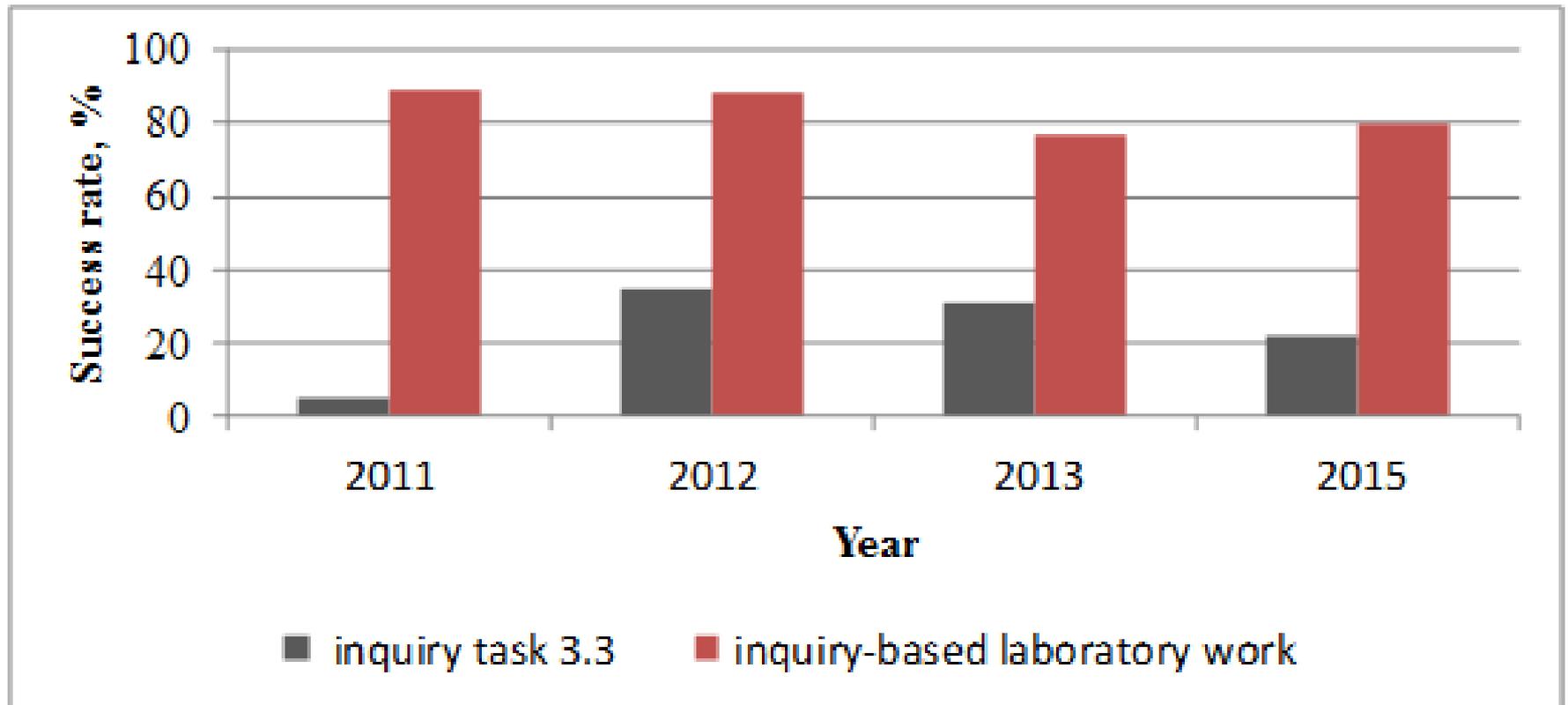
# Student Success Rate in CE in 2011 – 2015

Year	Number of Students	In General	Part 3	Task 3.3			
		Success Rate, %	Success Rate, %	Number of Mean Points	Standard Deviation	Max. Number of Points	Success Rate, %
2011	896	61.3	36.5	2.3	1.3	8	<b>28.5</b>
2012	665	59.3	44.7	2.9	1.6	6	<b>47.6</b>
2013	535	67.7	35.9	2.0	1.7	6	<b>33.6</b>
2014	561	59.5	46.7	3.4	1.5	6	<b>56.5</b>
2015	528	62.6	46.0	1.9	1.5	6	<b>31.7</b>

## Inquiry Skills Mastered by Students According to the Results of Task 3.3

Skills Tested by the Task	Success Rate, %			
	2015	2013	2012	2011
Identifies and formulates the research question	not tested	not tested	81	89
Formulates the hypothesis	not tested	not tested	47	44
Identifies and groups variables	33	no data	no data	no data
Identifies materials and equipment	68	50	42	11
Plans the procedure	22	31	35	5
Elaborates a data collection table	26	22	not tested	not tested

# Comparison of Mastering the Inquiry Skill "Plans the procedure" According to the Inquiry Task and ILW Record Assessment Results



# Inquiry Skill "Identifies and formulates the research question"

- The research question is written generally, unclearly or the research question envisages the answer to be in the form of a number. Example extracts from student CE works (E): *How to stabilise hydrogen peroxide decomposition for obtaining oxygen?; How high is amino acid concentration in dairy products?*
- It is difficult or even impossible to test the research question by experimental means. E: *Why can't uniform decomposition of  $H_2O_2$  be ensured?*
- The answer to the research question can be found in the situation text. E: *Does fermentation influence the amino acid concentration in dairy products?*

## ***Inquiry Skill "Formulates the Hypothesis"***

- The hypothesis does not give the answer to the research question. E: *If H<sub>2</sub>O<sub>2</sub> of different concentration are used the decomposition time will be different.* (The research question: Why can't uniform decomposition of H<sub>2</sub>O<sub>2</sub> be ensured?)
- The hypothesis does not contain any variable/ies. E: *If hydrogen peroxide solutions of various concentrations are decomposed at the presence of a catalyser, oxygen can be obtained.*
- The hypothesis formulation looks like a guess. E: *If MnO<sub>2</sub> is added when decomposing the hydrogen peroxide, the chemical reaction speed will be approximately 5.*
- It does not say how exactly the dependent variable will change. E: *If a bacteria strain is added to fresh air, the amino acid concentration will change during the fermentation process.*

# Conclusions

- The analysis of the CE results in chemistry shows that in general the national standard requirement on developing the students' inquiry skills is being implemented in the schools of Latvia.
- CE inquiry task measures inquiry skills mainly in the area of "Posing the research question and planning the procedure".
- The assessment results show that inquiry tasks have been causing difficulties to students over the period of five years. The students demonstrate the skills "Formulates the hypothesis, identifies materials and equipment to use, plans the procedure" with drawbacks.

- The inquiry skills in the part prepared by the school and in the inquiry task show different achievements: the students' success rate when carrying out an inquiry-based laboratory work at school is considerably higher.
- The inquiry-based laboratory work that is organised during the study process at school and the inquiry-based laboratory work record cannot be used as the CE measuring instrument of the inquiry skills.
- In order to test the students' inquiry skills, it may be necessary to change the approach to the measuring of the inquiry skills at the CE: to organise the student scientific inquiry during the examination or develop special tasks which contents and amount allow examining the majority of the inquiry skills.

**Thank you for attention!**

