JAGIELLONIAN UNIVERSITY
IN KRAKOW

SAILING ON AN ANALYTE – RESULTS OF A CASE STUDY ON GALVANIC CELLS UNIT AT UPPER SECONDARY SCHOOL LEVEL

Kinga Orwat

In Polish curriculum:

„(…) The student acquires knowledge in a research way - observe, checks, verifies, conclude and request (…)”

Teacher opion about implementaton of IBSE to the school practice in Poland[1]:

- Not enought time
- Problems with assessment
- Lack of sufficient laboratory equipment
- It is difficult for weaker students
- Poor teachers' preparation
- Poor cooperation between teachers
- Lack of students' preparation
- Lack of proper textbooks

Suppporting factors:

- Requirements of external examinations
- Motivation to learn
- Students' opinions
- Curricula
- School management
- Teacher unions
- Industry requirements

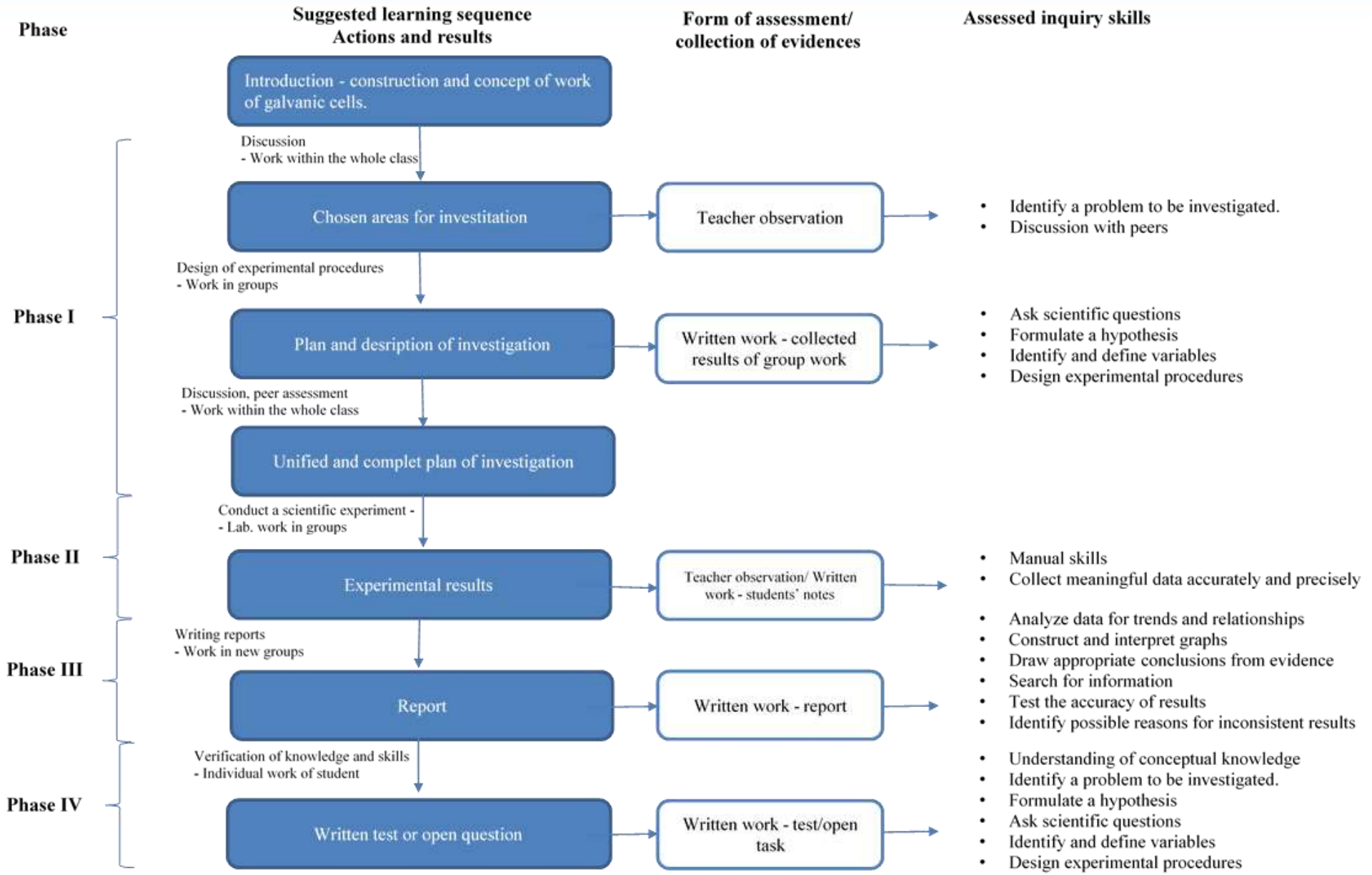
[1]Bernard P, Maciejowska I, Odrowąż, Dudek K. Introduction of inquiry based science education into Polish science curriculum - general findings of teachers' attitude. Chem Dydakt Ekol Metrol. 2012;17(1-2):49-59. DOI: 10.2478/cdem-2013-0004.

Learning prossess

Galvanic calles unit is adressed to students from upper secondary school, who lern chemistry at hight lewel.

Level of education/type **o**f school: **upper secondary**
Students' age: **17-18 y.o.**
Size of the group: **6 pupils**
Teacher's experience in IBSE: **first time uses IBSE**
Pupils' experience in IBSE: **first implementation**

Learning prossess



Assessment area

Assessed skills:

- Formulating hipothesis,
- Designing an experimental procedure
- Conclusions and evaluation

Assessment tools

Assessment tools
Formulating hipothesis

Aspects of the hypothesis evaluation:	YES	NO
The hypothesis is formulated in a simple and clear way - the more complicated formulation of the hypothesis, the more difficult its verification.		
The hypothesis is an adequate answer to the stated problem / research question.		
The hypothesis is at the appropriate level.		
The hypothesis is verifiable with the use of available resources / materials.		
The hypothesis is not obvious.		
The hypothesis has justification that is adequate for a particular level of education		

JAGIELLONIAN UNIVERSITY IN KRAKOW

Assessment tools
Designing an experimental procedure

POOR	CORRECT	VERY GOOD	EXCELLENT
Student: • partly selects reagents and laboratory equipment with the help of a teacher. • develops experimental method that does not take into account dependent or independent variable or does not develop any method • presents incomplete or inadequate sequence of causes and effects	Student: • selects reagents and laboratory equipment inadequately or with the help of a teacher • develops experimental method that takes into account dependent and independent variable • presents incomplete sequence of causes and effects	Student: • correctly selects reagents and laboratory equipment • develops experimental method that takes into account dependent and independent variable and some control variables • presents logical but incomplete sequence of causes and effects	Student: • correctly selects reagents and laboratory equipment • develops experimental method that takes into account all variables • presents complete sequence of causes and effects that takes into account all experimental conditions. • takes into account health and safety regulations

Assessment tools
Conclusions and evaluation

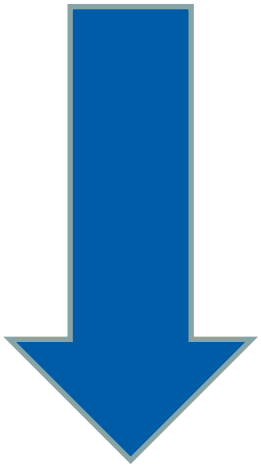
POOR	CORRECT	VERY GOOD	EXCELLENT
Student: • draws inadequate conclusions or draws conclusions with teacher's help • proposes unrealistic modifications of the experimental plan or modifications that do not have influence on the obtained results	Student: • draws some conclusions that are adequate to the obtained results • draws conclusions that allow the verification of the hypothesis • lists some measurement errors • proposes modifications to the plan of the experiment with teacher's help	Student: • draws conclusions that are adequate to the obtained results • draws conclusions that clearly verify of the hypothesis, • lists all the measurement errors, • proposes adequate modifications to the plan of the experiment	Student: • draws conclusions that are adequate to the obtained results • draws conclusions that clearly verify of the hypothesis, • presents a full and proper discussion of measurement errors • proposes adequate and real modifications to the plan of the experiment

Case study – results
Formulating hipothesis

Group A
"The greatest electromotive force can be obtained from the aluminum - copper cells at the following concentrations: $CuSO_4$ 0.5 mol/dm^3 and Al $(NO_3)_3$ 0.2 mol/dm^3 "
Group B
"By constructing a zinc - copper cell, we obtain the greatest electromotive force".

	Student 1		Student 2	
Aspects of the hypothesis evaluation:	YES	NO	YES	NO
The hypothesis is formulated in a simple and clear way - the more complicated formulation of the hypothesis, the more difficult its verification.	X		X	
The hypothesis is an adequate answer to the stated problem / research question.	X		X	
The hypothesis is at the appropriate level.	X		X	
The hypothesis is verifiable with the use of available resources / materials.	X		X	
The hypothesis is not obvious.	X		X	
The hypothesis has justification that is adequate for a particular level of education		X		X

Formulating hipothesis



Formulation and justification of hypothesis

Case study – results
Designing an experimental procedure

Group A

"Laboratory equipment: multimeter, two beakers, electrolytic key, copper plate, aluminum plate, measuring cylinder.

Reagents: $CuSO_4$, $Al(NO_3)_3$, $NaNO_3$

Plan: From the aluminum plate inserted into a beaker with a solution of $Al(NO_3)_3$ at a concentration of 0.2 mol/dm^3 a half-cell was constructed. Then, the second half-cell was constructed with a copper plate, and $CuSO_4$ at a concentration of 0.5 mol/dm^3 was poured into a beaker. The two half-cells were combined with the electrolyte key filled with a solution of $NaNO_3$. Multimeter was connected to the cel".

During the experiment, the students have constructed also the second cell consisted of the same half-cells as above but the concentration of *:* $CuSO_4$ was changed from 0.5 to 0.25 mol/dm^3.

Group	POOR	CORRECT	VERY GOOD	EXCELLENT
A	?		?	?
B	?		?	?

Case study – results
Designing an experimental procedure

POOR	CORRECT	VERY GOOD	EXCELLENT
Student: • partly selects reagents and laboratory equipment with the help of a teacher. • develops experimental method that does not take into account dependent or independent variable or does not develop any method • presents incomplete or inadequate sequence of causes and effects	Student: • selects reagents and laboratory equipment inadequately or with the help of a teacher • develops experimental method that takes into account dependent and independent variable • presents incomplete sequence of causes and effects	Student: • correctly selects reagents and laboratory equipment • develops experimental method that takes into account dependent and independent variable and some control variables • presents logical but incomplete sequence of causes and effects	Student: • correctly selects reagents and laboratory equipment • develops experimental method that takes into account all variables • presents complete sequence of causes and effects that takes into account all experimental conditions. • takes into account health and safety regulations

Case study – results
Conclusions and evaluation

Group B:
„To achieve the greatest EMF, metals with the highest possible difference in their potentials should be selected, for example forming the zinc-copper cell:

$$ZnIZn^{2+}IICu^{2+}ICu$$

To obtain even greater cell EMF, one can construct an aluminum-silver cell:

$$AlIAl^{2+}IIAg^{+}IAg$$

The concentrations of solutions can also be changed in order to obtain even greater electromotive force”

Group	POOR	CORRECT	VERY GOOD	EXCELLENT
A	X			
B	X			

CHANGES

- Conclusions and evaluation

- Conclusion
- Verify the hypothesis
- Empirical measurement errors
- any amendments / changes.

Conclusions

How to correct assessment of students?

- Discussion with students about criteria.
- Focus on assessment less skills.
- Creatures well-developed rubrics.

THANK YOU FOR YOUR ATTENTION