The inquiry laboratory in High School Chemistry: Development, Implementation, and Long-term Research

Avi Hofstein *

Rachel Mamlok-Naaman*

Dorit Taitelbaum **

*The Weizmann Institute of Science
** Ministry of Education
Why Inquiry laboratories?

- Development of high order learning skills
- An effective platform for research and assessment of students’ ability and progress.

and mainly

- A reform in the way high-school chemistry is learned, taught and assessed.
Inquiry Skills Involving Chemistry Students and their Teachers in:

- Hypothesizing
- Conducting an experiment
- Observing
- Asking questions
- Analysing
- Planning a new experiment to accept or reject hypothesis
The Inquiry Laboratory

- Duration: 15 years
- About 100 inquiry-type experiments were developed
- 5 PhD students were involved
- About 15 papers and book chapters were written
- About 30 CPD initiatives were conducted
Exemplary Research Studies

- Asking Questions
- Evidence-based Continuous Professional Development (CPD)
- Argumentation
Argumentation in the Chemistry Laboratory

Based on the PhD thesis of
Dvora Katchevich

Advisors:
Avi Hofstein and Rachel Mamlok-Naaman

Argumentation in Science Education: Why?

Based on literature – argumentation helps students in:

- Understanding the Nature of Science (NOS), and how science works.

- Attaining cognitive skills: asking questions, using scientific knowledge, hypothesising, drawing conclusions...
The Study

Hypothesis
Inquiry-type experiments are a perfect platform for formulating arguments

Research question
What factors encourage the formulation of arguments in a laboratory activity?

Population
11th and 12th grade chemistry students in Israel and their teachers (six classes)
Students Conducting the Inquiry-Type Experiments

- Small group discussions – “talking science”
- Explanation of observations
- Defining a research question
- Drawing conclusions
- Constructing a hypothesis
Students Learn the Argument’s Components in the Inquiry-type Experiments

Performing the experiment

Data, Evidence → Scientific explanation → Claim

Hypothesizing

An Argument

Based on Toulmin’s model, 1958
Research Tools

• Observations focusing on the discourse
• Students' laboratory reports
• Interviews with the students
Findings - based on the Analysis of the Arguments’ Components Raised by Students

From one experiment to another – an improvement in:

- The **number** of arguments
- The **level** of students’ arguments (based on a coding system)
- The **frequency** of students’ arguments
Students’ Quotations during the Classroom Discourse

"Come on let's rationalize our hypothesis…If there is a scientific basis, let's write it”.

“We know more or less (the experiment), but when it is necessary to phrase a research question, there are more discussions”.
Conclusions

The inquiry-type experiments indeed form an effective platform for formulating arguments.

Help students in improving their cognitive skills.
The CPD phases

1st phase: Development of learning materials (student activities and teacher's guide).

2nd phase: Summer induction course.

3rd phase: Workshop with forum on the web includes Videotape observations and Evidence-based portfolio.
Challenges Based on the CPD Research

Professionalizing and enhancement of chemistry teachers

To teach by inquiry
Challenges

- Motivating teachers
- The need for Continuous Professional Development (CPD)
- Assessing students’ achievements (e.g., Portfolio)
- Ways to encourage teachers to renew the list of the inquiry experiments they perform with their students

Professional Development (PD) conducted by the Ministry of Education
Summary

What have we learned in one of the longest R & D projects:

• Development of Inquiry –type chemistry experiments

• Design and implementation of effective model for continuous professional development of chemistry teachers

• Researching students’ development of high–order learning and thinking skills (skills for life)
Thank you!