Title: Use of modified laboratory instruction in chemistry practicals to help students acquire cognitive thinking and investigation skills

Author(s): Goh Ngoh Khang and Chia Lian Sai

Source: Tenth Divched Biennial Conference on Chemical Education - “Teaching Chemistry: A problem we can solve”, 31 July to 4 August 1988, Indiana, USA

Copyright © 1988 The Authors

This document may be used for private study or research purpose only. This document or any part of it may not be duplicated and/or distributed without permission of the copyright owner.

The Singapore Copyright Act applies to the use of this document.

Citation: Goh, N. K., & Chia, L. S. (1988, July). *Use of modified laboratory instruction in chemistry practicals to help students acquire cognitive thinking and investigation skills.* Paper presented at the Tenth Divched Biennial Conference on Chemical Education - “Teaching Chemistry: A problem we can solve”, Indiana, USA.

This document was archived with permission from the copyright holders.
Use of modified laboratory instruction in Chemistry practicals to help students acquire cognitive thinking and investigative skills

Goh Ngoh Khang
and
Chia Lian Sai

Paper presented at the
Tenth Divched Biennial Conference on Chemical Education—Teaching Chemistry: a problem we can solve
Purdue University, USA
July 31st—August 4th 1988
USE OF MODIFIED LABORATORY INSTRUCTION IN CHEMISTRY PRACTICALS TO HELP STUDENTS ACQUIRE COGNITIVE THINKING AND INVESTIGATIVE SKILLS

What is the Problem?

The content-oriented teaching and the mode of assessment of practical examination seem to have a certain impact in the way Chemistry teachers conducting the practical sessions in Singapore. As a result, teachers emphasize getting the "correct answer" during lab work and often resort to verification of something that is already known. In this situation, students' acquisition of cognitive thinking and investigative skills (Science process skills) is usually left to chance.

How to Solve the Problem?

In order to remedy this problem, the Modified Laboratory Instruction (MLI) of Qualitative Analysis in Chemistry at Grade 9 (Secondary Three level) had been conceptually constructed as follows:

Conceptual Framework of MLI

Achievement of Performance in Science Practicals

Stage 2
On-going and continual monitoring

Manipulative Skills ——> Observational Skills ——> Inferential Skills

Stage 1
Handouts and Assignments

Mental Preparation ——> Following Instruction

It shows:

- how the development of cognitive thinking and investigative skills can be systematically achieved and also
- how the acquisition of such process skills may in turn determine the students' achievement in science practicals, in particular qualitative analysis.

The direction of each arrow in the above figure is intended to convey the importance of a preceding action on the outcomes of another action.

The following are some of the features of the MLI:

- Science process skills are systematically organised and introduced;
- Continuous monitoring of students' performance in the process skills is carried out with immediate coaching;
- The students are provided with feedback about "what", "how" and "why" with respect to the skills used, design of experimental procedure and their mistakes made.

In contrast, the conventional laboratory instruction (CLI) relies very much on the individual teacher. Commercial laboratory manuals are usually adopted. Some teachers design their own worksheets, while others make use of past examination papers. Whatever the variation, the acquisition of process skills under CLI is usually left to chance.

What was the Study?

The study attempted to make use of the Modified Laboratory Instruction (MLI) to improve the students' achievement of process skills.

A sample of 164 ninth-grade subjects drawn from four classes in two schools, was participating in this research project. Two (intact) classes in each school with comparable academic performance were randomly selected and assigned, one as experimental group and the other as a control group.
Before the implementation, all the teachers concerned have come to the following agreement:

- same content and process skills coverage
- identical time frame
- same types of assessment

Teachers involved in the experimental groups were briefed in detail on the MLI and the materials to be used. Teachers involved in the control groups were told to carry on their laboratory work in their usual (conventional) way. The content of the Chemistry practicals includes studying properties of some common salts and detecting some common cations and anions in known and unknown samples which are covered by the 'O' level Chemistry syllabus.

After the treatment, both experimental and control groups were each given a traditional practical test and an alternative-to-practical test. While the former deals with following instructions, recording observations, and making deductions, the latter is a paper-and-pencil test which taps skills not covered by the former. The two tests complement one another. In addition, both groups had also completed an attitude test.

Results of the Study

The results of the post-test and the alternative-to-practical test are shown in the table on the next page.

<table>
<thead>
<tr>
<th>School Type of Test</th>
<th>Group</th>
<th>N</th>
<th>( \bar{X} )</th>
<th>S.D.</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EG</td>
<td>Post-Test</td>
<td>43</td>
<td>49.47</td>
<td>9.57</td>
<td>14.93</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>CG</td>
<td></td>
<td>39</td>
<td>23.86</td>
<td>5.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EG</td>
<td>Alternative Test</td>
<td>43</td>
<td>64.22</td>
<td>14.08</td>
<td>6.13</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>CG</td>
<td></td>
<td>39</td>
<td>45.66</td>
<td>13.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EG</td>
<td>Post-Test</td>
<td>42</td>
<td>54.00</td>
<td>12.70</td>
<td>0.87</td>
<td>n.s.d.</td>
</tr>
<tr>
<td>CG</td>
<td></td>
<td>40</td>
<td>51.50</td>
<td>13.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EG</td>
<td>Alternative Test</td>
<td>42</td>
<td>65.00</td>
<td>12.50</td>
<td>8.23</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>CG</td>
<td></td>
<td>40</td>
<td>44.30</td>
<td>10.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By careful analysis of the above test results, we are confident to suggest that the Modified Laboratory Instruction, which emphasizes on the mastery learning of process skills, has led to improved quality of performance at practical work.

The study also reveals that attitude towards practical work of the experimental groups is better than that of the control groups as reflected by the performance in the attitude test.

Implications for Teaching

The positive effect of the MLI on the achievement of Chemistry practicals implies that the necessary ingredients for promoting the acquisition of process skills are:

- proper skills and techniques systematically organized and taught by the teachers;
- the formative monitoring of process skills by the teacher;
- the provision of mental preparation to act as motivator;
the design of clear experimental procedures which provide students with the "why" and "how", vis-a-vis the cause-effect of a particular procedure;

* the identification of the reason when students make a mistake, to help them avoid making the same mistake in future.

* the use of proper mode of assessment of practical work.

References


DR GOH NGOH KHANG
DR CHIA LIAN SAI

Bukit Timah Campus
469 Bukit Timah Road
Institute of Education
Singapore 1025