Do Students perform in an Inquiry Based Learning Approach as assessed by a Formative Assessment to Inquiry approach in a Chemistry Laboratory task involving Chemical Change?

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Abstract

This work is directed towards enhancing student understanding of what it means to be a chemist in the laboratory in terms of working safely with materials, displaying the descriptors capacity to carry out a laboratory investigation, working as a group, recording results, presenting results and interpreting the same results to develop a hypothesis. A 'hands-on', ' minds-on' Inquiry Based learning approach with Transition Year students (aged 15-16 years), as an Irish school setting was used over an eighty minute lesson. Not all students had a qualification in science education at junior school level (Junior Certificate Science). Students were free to select from available combinations of chemicals, mix and match them in tripod flasks and observe the results. The household chemicals involved in all of the experiment are available in supermarkets. The chemistry involved includes acid-base, stoichiometry and quantitative detection of starch. The Inquiry Based Learning Approach was experienced by students, for whom formal teacher instruction did not exceed four minutes, was coupled with a formative assessment to generate student performance indicators. Students exhibited competence in terms of their ability to perform the work of a chemist in terms of both the 'minds-on' and 'hands-on' aspects of the lesson. They also experienced fun and engaged well in their groups.

Introduction

Ireland is in the process of changing its Chemistry curriculum which will be aligned with new forms of both written and practical assessment. Senior Cycle has largely undergone a significant phase of review. Following research and consultation with teachers, science managers bodies, the development of more flexible programmes of learning, online-based syllabi for subjects and short courses, the development of key skills and new ways of assessing will be developed. The NCVA (2012) highlights that assessments should change from its present format and that future assessments should engage in Inquiry-based learning with an attendant change in focus on practicals, as currently undertaken. This experiment is adapted from another version (see Selic et al. 2011), in an attempt to embed these ideas in a chemistry laboratory setting. Students in this lesson are in their first year of Senior Cycle and have completed the national Junior Certificate examination. It is a no-makes, formative year which informs their decisions towards subject options for the remaining two years of this cycle. The Inquiry Based Learning nature of the lesson allows for a heuristic approach whereby students carry out 'hands-on' activities in the laboratory. They are asked to present their results and use their observations, to help them ask a question or make a hypothesis regarding chemical change. The time restrictions of the lesson generally limit the various groups to a single hypotheses but this can vary.

An attempt to chart a learning pathway which might provide some reference points for assessment was undertaken by the teacher. This resulted in a competence model in terms of an assessment framework. It was useful to reflect on the complexity of the task within the framework in Figure 1 below so as to visualise an assessment context and anticipate the aims mentioned, 'reference points' for such a framework.

Methodology

The materials used in this experiment included six powders labeled A 9-3F and six liquids labeled I 9-3Y. All chemicals were presented as shown in Figure 2 and an instruction sheet was provided to each individual student to facilitate data collection. Two sets of 24 results could be modified to further challenge more senior students if deemed appropriate. Each group of two students performed eight different tests with randomly chosen sets of chemicals and recorded their observations in a table of results. During this time, students should have been noticing (potential) patterns of results develop and making inferences as to what powders or liquids are most likely to cause a certain type of chemical change. This forms the basis for their hypothesis. Some hypotheses are shown in the 'Results (Showing Hypotheses)’ section.

Results (Showing Hypotheses)

Figure 2: Five Levels of Hierarchical Complexity for task development and analysis of Student's achievement in Chemistry (Bransford et al. 2012).

Figure 3: Results (Showing Observations)

Concluding

Students completed the experimental activity with enthusiasm while engaging fully with the task and each other. All scored very well in the assessment and one point of note was one student whose previous academic record was exceptional performed all others in the assignment. The presentation gave students who were not inclined to speak publicly or not inclined towards scientific communication confidence from showing their observations to their peers. Also of note, was the proclamation of a student who had not undertaken Science as a subject in the Junior Certificate, that she was continuing to the Leaving Certificate Chemistry programme, the following year. Thus the objective that the class would undertake a 'hands-on', ' heads-on' experiment, developed into a 'hearts-on' experience for some and was thoroughly enjoyed by all. The phones ‘Ring’ was used by students on a number of occasions throughout the lesson. The teacher instruction ‘during the lesson’ did not exceed four minutes. The opportunity to be a real chemist and take ownership of their work, was evidenced by students recalling accurate details of the investigation some weeks later.

References


This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement no 289085.