DIFFICULTIES IN TEACHING AND LEARNING PHASE EQUILIBRIUM AT G.C.E ADVANCED LEVEL

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Introduction

Equilibrium has been regarded as one of the most difficult area to learn and teach at G.C.E advanced level. A review of examination reports reveals that students have difficulties in solving problems about equilibrium. It is also an area about which many students possess misunderstanding (Bergquist & Heikkinen, 1990). The reason is that when students develop inappropriate links with their prior knowledge they construct meanings that are not scientifically accepted (Driver *et al.*, 1994). Hence, many students encounter difficulties in learning. To enhance meaningful conceptual understanding in equilibrium, it is essential to understand what ideas that students hold about equilibrium concepts and how these ideas impact on their learning. This study investigates the learning difficulties in teaching and learning phase equilibrium in advanced level chemistry classes.

Methodology

376 students were selected from twenty four 1AB urban schools in central province as the sample. Students were in grade thirteen (second year of G.C.E advanced level programme whose ages ranged from 18-19) from both biological science and physical science streams. In the first step diagnostic test paper was developed based on the content of phase equilibrium in physical chemistry syllabus at G.C.E advanced level. Twenty open-ended test items were constructed. All items were pilot tested on 28 students and required modifications were made prior to the administration of the test. Then the test was administered among the sample of the students. Responses were marked and coded into four categories: no response, misunderstanding, partial understanding and sound understanding. In the second step semi-structured interviews were carried out with fifty students according to their written responses which reflected different perspectives. These interviews were conducted to obtain a more elaborated source of data on their underlying beliefs impacting on learning. In order to understand teachers' problems in teaching phase equilibrium, 30 chemistry teachers were interviewed and 10 classrooms were observed to find out what was real situation in the chemistry classes. Data collected from multiple methods were analyzed qualitatively and quantitatively.

Results and Discussion

Analysis of written responses showed that half of the students have below the average mark of 36. This indicates that the students face difficulty in understanding the concepts of phase equilibrium. 78% of the students failed to conceive the dynamic nature of phase equilibrium. 69% of the students did not realize that evaporation and condensation process occur simultaneously and continuously. They responded that microscopic process stops at equilibrium level. Students were not able to produce explanation at microscopic level. They were also unable to define the terms constitution equilibrium satisfactorily. 62% of the students had difficulty in distinguishing between the terms—"phase" and "phase region". Interview results show that 40% of the students misuse the term "component" and "phase". Students had insufficient understanding about vapour pressure of equilibrium. 56% of the written responses indicates that equilibrium vapour pressure depends on the volume of container in which liquid is present. 72% of the students responded that equilibrium vapour pressure depends on the initial volume of liquid. 60% of the written responses show that misinterpretation of the relationship between vapour pressure and boiling point of a liquid. Even the students who had expressed correct relationship between vapour pressure and boiling point could not explain the phenomenon behind it. Students had insufficient knowledge in colligate properties. A common misconception (53%) had been that boiling point elevation and freezing point depression occur because of the interaction between the water molecules and salt

particles in salt water. The students viewed that the evaporation of water would be difficult because of the interaction between salt ion and water molecules, so that the temperature increases. The term volatility was used incorrectly by students. Although 40% of the students could apply the Raoult's law equation, they too had misunderstanding about the phenomenon. 28% of the students responded partial pressure of a liquid is equal to total vapour pressure multiplied by mole fraction. Even though students had learned the terms mole and concentration at secondary level still they have misunderstanding regarding the concepts. Further students had confusions on physical change and chemical change. Students regarded dissolving as a chemical change. 75% of written responses indicated that dissolving salt in water as a chemical change. The students regarded a mixture not as an entity with its own chemical and physical properties but as a collection of components that behave independently. Furthermore, the students failed to relate phase equilibrium with real world examples.

Analysis of classroom observations revealed that teachers have difficulty in introducing and explaining the concepts of phase equilibrium. They did not use any examples from real world in explanation. They tried to transfer the subject matter directly. 90% used only lecture method and presented facts. They did not allow thinking in learning. They did not relate in any way to the chemistry of

everyday life. No practical work was done in any observed classes. Teachers tried to explain facts which did not help students to build up concepts. Students had no opportunity to express their ideas or discuss their ideas with others. Assessments were also based on recalling facts and not on applications or further thinking. Teachers expressed that students were not interested in learning phase equilibrium topics. They had difficulties in motivating students.

Conclusions

The results of this study show that students at G.C.E advanced level are having difficulties to build up concepts of phase equilibrium. The way teachers taught was the main cause for these difficulties. In order for students to have a meaningful understanding of these concepts it is necessary that they
have to build up concepts in equilibrium. If chemistry teachers can identify students' difficulties in learning and the origin of their misconceptions then their teaching could be improved to help in students' learning. Therefore teachers should use alternative approaches in teaching chemistry and assessing students learning where students can express and discuss their ideas and clarify their doubts and misunderstandings.

References

Bergquist, W., and Heikkinen, H. (1990). Students' ideas regarding chemical equilibrium: what written test answers do not reveal. Journal of Chemical Education, 67, 1000-1003.

Driver R., Squires A., Rushworth P. and Wood-Robinson V., (1994). Making sense of secondary science: research into children's ideas. London