

IDENTIFICATION OF DIFFICULT TOPICS IN THE TEACHING AND LEARNING OF CHEMISTRY IN IRISH SCHOOLS AND THE DEVELOPMENT OF AN INTERVENTION PROGRAMME TO TARGET SOME OF THESE DIFFICULTIES

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Rationale and Aims

The rationale for carrying out this research project lies in the well documented findings in the literature that most students at secondary school find chemistry to be a difficult subject. This is due to the conceptually demanding nature of the subject giving rise to low participation rates at Leaving Certificate level. Only 7,000 students approximately take Leaving Certificate chemistry, a participation rate of only 13% of Leaving Certificate students.

The aim of this research is to develop an intervention programme to help students cope with a selection of topics on the Junior Certificate and Leaving Certificate programmes. It is hoped that this intervention programme would improve the cognitive development of the students and thus enable them to cope more readily with certain difficult topics in chemistry.

Overview of the research topic

The literature review carried out for this study provides a valuable overview of the research topic. This is wide ranging and synthesises the key elements of science education research related to misconceptions in chemistry.

The researcher makes good use of the work on cognitive acceleration in science education (CASE) carried out by Shayer and Adey in the UK. CASE was developed in the 1970s at Chelsea College in London as a response to the fact that the science curriculum in the UK made demands beyond the intellectual capabilities of most of the students. The aim of the CASE project was to develop the thinking abilities of students, initially among 11-14 year olds, in order for them to better attain the objectives of the curriculum. The CASE team worked on the premise that it was possible to teach general thinking skills that would benefit the students by developing their higher order thinking skills. In short, the work of Shayer and Adey documents that one of the reasons why pupils/students find certain aspects of chemistry difficult is as a result of having not yet reached the formal operational stage of cognitive development. Cognitive development is the basis of the work of Jean Piaget showing that children's thinking passes through a series of stages that progressively show greater sophistication. Piaget outlined the transition of children's thinking from the concrete operational period of childhood to the formal operational period of adolescence. Hence, an attempt is made to "accelerate" the rate at which students reach this formal operational stage.

The second aspect of the overview of the research topic carried out by the researcher highlights the fact that in chemistry education research, the existence of misconceptions in the mind of the student has a major effect on the learning of chemistry.

Overview of work carried out

This research project forms part of a three-part investigation into the difficulties in the teaching and learning of chemistry in the Irish school system. The first phase was the identification of the areas/topics in chemistry that the majority of Irish pupils and students perceive as being difficult. Phase two was the determination of the reasons why students find the topics identified in phase one of the study difficult. Phase three was the development, implementation and evaluation of a teaching package, designed to alleviate difficulties pupils have with some of the topics identified in phase one as being difficult.

Findings / Recommendations

Results from the first two phases of this investigation revealed a number of topics that the Leaving Certificate pupils found difficult. These included Organic Reaction Mechanisms, Organic Synthesis, Chemical Equilibria Calculation, Volumetric Calculations, Redox Reactions, and Concentration of Solutions. To summarise these topics under a small number of main headings it would appear that Leaving Certificate Chemistry pupils have difficulty with:

- Organic chemistry topics
- Chemistry topics that involve mathematical manipulations
- Topics that need a firm understanding of the particulate nature of matter in order to be understood

An overall summary of the results and findings are that:

- The difficulties in chemistry for Irish pupils and students persist throughout the system from Junior Cycle level to university level.
- The topics that are causing the majority of the pupils/students problems are topics that have a high cognitive demand.
- The pupils' ability in maths has a major effect on how easy or difficult a pupil finds a topic in chemistry.

Many misconceptions held by Irish chemistry pupils were unearthed in this study. For example, it was found that the majority of pupils believe that:

- Air fills the space between particles of different substances.
- When a substance dissolves it disappears.
- When a substance is heated the atoms expand in size.
- When water melts it splits into hydrogen and oxygen.
- Copper tarnishes as a result of shiny atoms going dull.
- Gold atoms are gold in colour.
- Diluting fruit juice is a chemical change.

Conclusion

This study is based firmly on the science education literature in the area of cognitive acceleration. The methodology employed is in keeping with best practice and utilises the standard research instrument commonly used in science education research. The key findings that the majority of Irish pupils have not yet reached the formal operational stage of cognitive development and as a result have difficulty with the abstract topics is important for curriculum developers in Ireland. In addition, the fact that it has been clearly demonstrated by the researcher that a high percentage of Irish pupils possess misconceptions about the most important fundamental topic required for basic understanding in chemistry (the Particulate Nature of Matter) is of relevance to those involved in teacher education at all stages of the continuum.

The intervention programme carried out makes appropriate use of cognitive acceleration strategies to clarify misconceptions in the minds of the students. The research strategy used by the researcher to include the 'Thinking Science' methodologies within the existing curriculum was also worthwhile.

The study followed appropriate methodological and ethical research standards.