
Title	Instructional technology for supplementary learning of process skills
Author(s)	Raymond Tsoi Mun Fie, Goh Ngoh Khang and Chia Lian Sai
Source	<i>ERA-AME-AMIC Joint Conference, Singapore, 4-6 September 2000</i>
Organised by	Educational Research Association of Singapore (ERAS)

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.

INSTRUCTIONAL TECHNOLOGY FOR SUPPLEMENTARY LEARNING OF PROCESS SKILLS

Raymond Tsoi Mun Fie, Goh Ngoh Khang & Chia Lian Sai
National Institute of Education
Nanyang Technological University

Abstract: The teaching and learning of process skills in chemical qualitative analysis is a difficult task for both the teacher and the students due to instructional and external factors. The instructional method employed is usually to demonstrate certain known concepts and provide hands-on laboratory practicals for practice rather than to promote the acquisition of process skills. Factors like time constraint and safety also aggravate this situation and as a result, there is limited learning experience for the students to acquire the process skills of manipulative, observation and inference. As such, this paper concentrates on the pedagogical design and appropriate use of instructional technology in the area of CD-ROM to supplement the learning of process skills. Certain design issues and learning principles in the development of the CD-ROM will be illustrated using instructional storyboard and product developed. Implications for the design and use of such technology will also be discussed.

Introduction

In the learning of process skills in chemical qualitative analysis, the common practice employed is mainly to demonstrate known concepts and provide hands-on laboratory based practicals rather than to promote process skills of manipulative, observation and inference. Factors like time constraint and safety also aggravate this situation. Since process skills like the thinking skills could be transferred to situations that require inquiry and problem-solving, the acquisition of such science process skills would then be essential. As such, multimedia CD-ROMs integrating different presentation modes such as sound, text, images, videos, graphics, and animations may be used to supplement the learning experience. This may also allow students to be more exposed to the three levels of understanding such as macroscopic which deals with sensory/visible phenomena such as laboratory observations, and data; the microscopic which deals with particles such as atoms, ions and molecules; the symbolic which represents the matter in terms of chemical formulae and equations (Johnstone, 1991; Gabel, 1993).

Instructional Technology Design

In the design of learning materials, since content organisation plays an essential role, there has to be a congruent and complementary integration of the different presentation stimuli to put across concepts in internally consistent and coherent segments. Essential design decisions such as determining the goal of the instruction and the pedagogical approach where learners are to be engaged not only in meaningful instructional tasks but also in active learning need to be made (Merrill, 1988; Wilson & Cole, 1991; Boyle, 1997).

Figure 2 illustrates the translation of the instructional storyboard as shown in Figure 1 into the product developed. The principle in using visualisation that elicit effective visual and verbal information processing (Graham, 1988; Carroll & Bandura, 1990) is considered as in Figure 2 where visual demonstrations accompanied by verbal coding

or cues are used. The video can be scanned rapidly to look for important points and the ease of such access to any part of the video can help to enhance the learning process and promote process skills. Concept maps for conceptual relationships are incorporated functionally in the design (Jonassen & Wang, 1993). As such, the effectiveness of dual coding is raised.

Date:	Previous:	Next:	Frame: 2020
Project Title: CHEM 'O' LEVEL		Section: Qualitative analysis	
Screen Display/Graphic/Text:		Qualitative Analysis Tests for Cations	
<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px;">COLOURLESS IONS</div> <div style="border: 1px solid black; padding: 5px;">COLOURED IONS</div> </div>		CONCEPT MAP	
<p>The three coloured ions are copper (II), iron (II) and iron (III).</p> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 45%;">Video on the reaction between aqueous sodium hydroxide and the coloured ions</div> <div style="border: 1px solid black; padding: 5px; width: 45%;">Video on the reaction between aqueous ammonia and the coloured ions</div> </div> <p>Observe the distinct colour of the precipitate that identifies the cation.</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 5px; width: 40%;">System and General Tools</div> <div style="text-align: center;"> ← → </div> </div>			
<p>Programming Instructions:</p> <p>1. pop-up window for both videos for comparison</p> <p>System Tools: Help, Tools (Search, Glossary, Internet), Main Menu, Quit, Home, Return</p> <p>General Tools: Periodic Table, Concept Map, Calculator, Notepad, Lesson Planner, Print, summary</p>			

Figure 1: Instructional storyboard

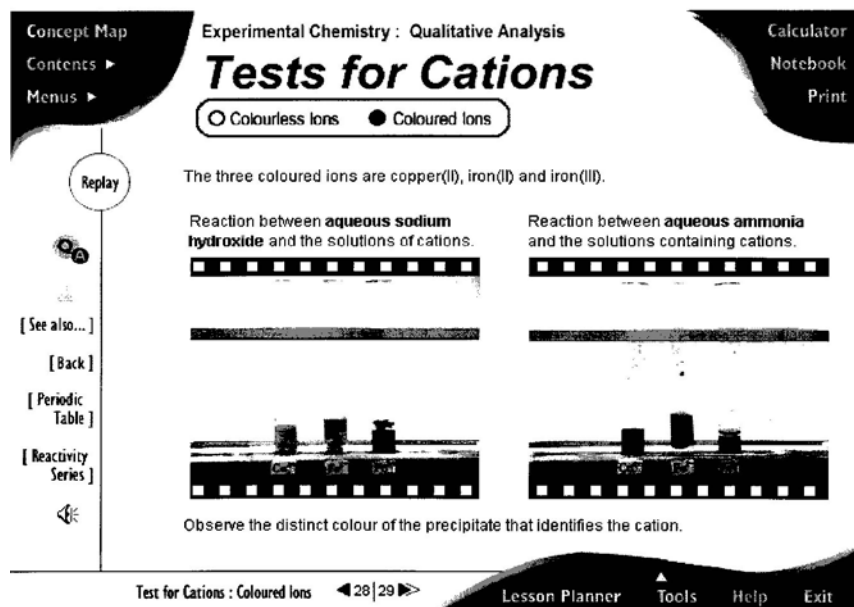


Figure 2: Screenshot

Figure 3 is an instructional storyboard for the design of a demonstration of an instructional task or process skills such as manipulative and observation. Since observational learning is a critical part of the development of process skills, it is therefore important to demonstrate the task or process skill especially manipulative skill as clearly and unambiguously as possible. In this case, it is a demonstration of

the tests for neutral gases such as hydrogen and oxygen. An explicit video demonstration cum explanation may be necessary to rationalise the observations made.

Date:	Previous:	Next:	Frame: 2015
Project Title: CHEM 'O' LEVEL		Section: Qualitative analysis	
Screen Display/Graphic/Text:			
Qualitative Analysis Tests for Gases			
NEUTRAL GASES	ALKALINE GASES	ACIDIC GASES	CONCEPT MAP
<p>Gases are sometimes evolved during heating of an unknown substance or chemical reaction between reagents. Such gases can be neutral, alkaline or acidic. Neutral gases such as hydrogen and oxygen are colourless and odourless. They do not turn moist litmus paper to blue or red.</p>			
Video on the test for hydrogen using burning splint	Video on the test for oxygen using glowing splint		
System and General Tools			← →
Observe and record your findings using the notepad.			
Programming Instructions:			
1. pop-up window for both videos for comparison			
System Tools: Help, Tools (Search, Glossary, Internet), Main Menu, Quit, Home, Return			
General Tools: Periodic Table, Concept Map, Calculator, Notepad, Lesson Planner, Print, summary			

Figure 3: Instructional storyboard

Experimental inquiry can also be incorporated in the instructional task for tests of cations and gases to enhance the learning of process skills. Figure 4 shows the graphic organiser that can be used in the process of experimental inquiry. This is a process of observing a macroscopic event of phenomena, analysing it to generate an explanation, making a prediction based on the explanation, testing the prediction and re-evaluating the original explanation. Indeed, the learner can make predictions before viewing the rest of the videos and then carry out the experiment to validate the prediction or in this case the results observed. Questions such as "What do you observe?", "How can you explain it?", "What if ...?", "How can you test your "what if ...?", "What happened?" can be asked during the process of inquiry. This would certainly strengthen the understanding of the concepts.

Implications

Visual graphical representations, for example, concept maps can be employed to show certain conceptual relationships and elicit thinking. Video, an example of visualisation, can be used effectively to help learners to perceive and process information thereby increasing the depth and fluency of observational learning. Consistent visual cues to provide functionality such as the purpose of the buttons, icons or menus; and feedback for learner actions, for example, the highlighting of buttons or icons when they are 'pushed' or 'clicked' to signal screen transitions; should be offered. General and system tools need to be strategically positioned for easy access to other features or information. As such, this will imply not only design for progressive disclosure (Apple, 1992) to reduce cognitive load but also design suitable coding mechanisms for effective dual coding (Paivio, 1979).

The importance of content design will also continue to be of great importance even in the most advance created multimedia technological environment. Good and effective instructions are based upon the appropriate selection and proper organisation of various instructional strategies that elicit processes, and not simply the medium per se. Indeed, learning via multi-modal instruction would improve when there is significant conceptual and temporal overlap between the information presented in each modality.

On the whole, one needs to consider the incorporation of the common features of an instructional system design ranging from determining and analysing the instructional goal; writing performance objectives to developing instructional strategies and designing and conducting evaluation. Essentially, an awareness of the transferability of both design knowledge and skills acquired in the design process to another multimedia project is desired.

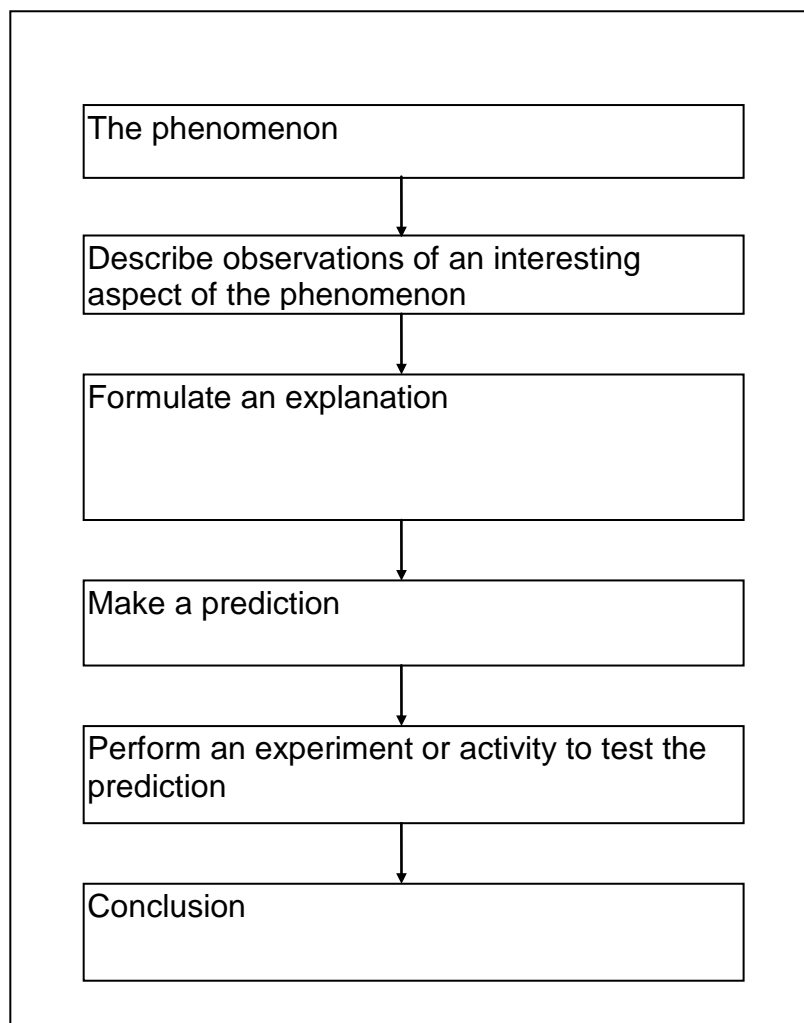


Figure 7: Graphic organiser for Experimental Inquiry

References

- Apple Computer Inc. (1992). *Macintosh Human Interface Guidelines*. Addison-Wesley.
- Boyle, T. (1997). *Design for Multimedia Learning*. Prentice hall.

- Carroll, W. R., & Bandura, A. (1990). Representational guidance of action production in observational learning: A casual analysis. *Journal of Motor Behaviour*, 22(1), 85-97.
- Gabel, D. L. (1993). "Use of the particle nature of matter in developing conceptual understanding", *Journal of Chemical Education*, vol. 70, pp. 193-194.
- Graham, K. D. (1988). A qualitative analysis of an effective teacher's movement task presentations during a unit of instruction. *Physical Educator*, 45(4).
- Johnstone, A. H. (1991). "Why is science difficult to learn? Things are seldom what they seem", *Journal of Computer assisted Learning*, vol. 7, pp. 75-83.
- Jonassen, D., & Wang, S. (1993). Acquiring structural knowledge from semantically structured hypertext. *Journal of Computer-based Instruction*, 20(1), 1-8.
- Merrill, M. D. (1988). Applying component display theory to the design of courseware. In D. H. Jonassen (Ed.), *Instructional designs for microcomputer courseware*. Hillsdale, N J: Lawrence Erlbaum Associates.
- Paivio, A. (1979). *Imagery and verbal processes*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Wilson, B., & Cole, P. (1991). "A review of cognitive teaching models", *Educational Technology Research and Development*, vol. 39, no. 4, pp. 47-64.