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INSTRUCTIONAL TECHNOLOGY
FOR SUPPLEMENTARY LEARNING OF PROCESS SKILLS

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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.

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The three coloured ions are copper (II), iron (II) and iron (III).

Video on the reaction between aqueous sodium hydroxide and the coloured ions

Video on the reaction between aqueous ammonia and the coloured ions

Observe the distinct colour of the precipitate that identifies the cation.

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 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.

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.

Video on the test for hydrogen using
burning splint

Video on the test for oxygen using
glowing splint

System and General Tools

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 advanced 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](image)

**References**


