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Author(s)	Quek Choon Lang and Angela Wong
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Developing An Organic Chemistry CD-ROM for Enhancing Teaching Among Gifted Students

Quek Choon Lang, Raffles Institution, Singapore
&
Angela Wong, Nanyang Technological University

Introduction

With the Singapore government's formulation of IT2000-A vision of an intelligent island in 1991, IT has an essential role in the country's competitiveness and economy. The $2 billion IT Masterplan by the Ministry of Education (MOE) was developed as the blueprint for the integration of information technology in education as a strategy to meet the challenges of the 21st century (Ministry of education, 1997). The National Institute of Education (NIE) has stepped up its IT training which includes the use of the Internet and IT-based teaching for trainee teachers. Also as part of the IT Masterplan, the newly formed Educational Technology Division (ETD) in 1996, under the MOE has also provided teacher training in IT in all Singapore schools. These changes, along with greater attention to IT research, are in line with the MOE's 6 year Masterplan (de Sousa, 1997). This is the first time in the history of Singapore education that the Government has put in so much support in terms of finance, infrastructure and training towards educational change. The MOE has now adopted a more dynamic view of schooling in which teachers guide pupils through individual and collaborative activities that encourage inquiry and the construction of knowledge.

In response to the changes ahead, the integration of IT into the curriculum seems to be the way to teaching and learning in schools. Research seemed to indicate that IT use could develop the pupils' thinking and critical faculties and that it contributed to their communication skills and confidence levels. The researcher was also keen to find out how the use of IT could further enhance the learning experiences and outcomes of the pupils in her classroom.

Background

In this study, 100 secondary 4 pupils (aged between15-16) came from the Gifted Education Programme (GEP) in Raffles Institution. It can be assumed that the pupils are already formally exposed to creative thinking in their curriculum either since primary 4 (aged 10) or in secondary school. Both the pupils and the chemistry teacher are comfortable with the use of computers. These pupils learnt basic programming, publishing programmes and the use of Internet in the lower secondary computer studies syllabus.

Purpose of the study

At the upper secondary level, Organic chemistry is the last major topic in the 'O' level chemistry syllabus. Due to the lengthy content in this topic, pupils often resort to simply rote learning of concepts. As a result, the pupils either could not apply the concepts or just do not choose the organic chemistry questions in the examinations. For pupils who intend to study 'A' level chemistry, organic chemistry is an important topic in the chemistry syllabus. Therefore pupils must build up firm foundation and positive attitude while studying 'O' level organic chemistry. With this concern in mind, the researcher decided to use IT to enhance teaching and learning in organic chemistry.

The purposes of the study were to:

1 Develop specific IT-based projects by:
(a) conducting IT-based project group work in organic chemistry, and
(b) evaluating the pupils' learning experience in the IT-based project by means of the Questionnaire on Developing and Using Organic Chemistry CD-ROM (section A).

2 Develop an Organic Chemistry CD-ROM by:
(a) conducting IT-based lessons for pupils, and
(b) evaluating the pupils' learning experience with the customised CD-ROM by means of the Questionnaire on Developing and Using Organic Chemistry CD-ROM (section B).

Related Literature Review

A brief review on the use of the IT in education will provide a rationale for integrating it into the curriculum. Back in the 70s, schools all over the world and Singapore had implemented some aspects of computers-in-education (Hawkridge et al., 1990). In the 80s, educational decision-makers realised the potential impact of computer applications and great emphasis was placed on our school system as well as the tertiary institutions. In the 90s, with the technological advancement, the focus now is on the computer network rather than just the computer. Collis (1996) notes that the use of Wide-Area Network (WAN) capabilities for telecommunication and access to new forms of information engagement is stimulating a wave of initiatives with respect to telecommunications in schools, and in particular telecommunications via the Internet and applications such as E-mail and the World Wide Web (WWW).

Research reveals a multitude of the exploration of innovative uses (Levin & Thurston, 1996). For example, the telecommunication networks allow the locating and collecting of the most current and materials which can be disseminated in large quantities simultaneously to many people (Hancock & Betts, 1994). These networks have made new forms of local and world-wide collaborative learning possible. As a result, different interest groups such as languages, mathematics and sciences were formed by people from all over the world. These interest groups such as writing (Scardamalia et al., 1992; Bruce & Rubin, 1993), Science-Learning Through Collaborative Visualisation Project (Ruopp et al., 1993; Bradsher & Hagan, 1995) and Mathematics (Klotz, 1996) were formed to bring together pupils, teachers and adults to share and contribute ideas via the telecommunication networks.

With the integration of IT in learning, pupils gained a wider range of learning experiences far beyond what the traditional classrooms could provide (Hancock & Betts, 1994). It was also reported that teachers were able to give individual attention, allow more independent work and accommodate different learning styles. There was a shift from teacher-centred classrooms to student–centred ones. The teacher is a facilitator/coach rather than information dispenser. In other words, this setting would allow more collaboration and group work to take place.

A two-year project - The Apple Classsrooms of Tomorrow (ACOT) was initiated by Apple computers (1986-1987) for K-12 schools in the United States. This study (Dwyer, 1994) wanted to find out whether routine use of computers would affect how students learnt and how teachers taught. In this project, each participating pupil and teacher received two computers: one for the home and one for the school. It was found that ACOT students performed better in standardised test scores than their peers in non-ACOT classrooms. In addition, there was also a transformation in the behaviour of both teachers and students. It was observed that students were taking more responsibility of their learning and teachers were working more as mentors and less as presentors of information.

The reviews have shown that telecommunications and computer technologies have great potential for revolutionising teaching and learning. With a deeper understanding of these technologies and possible benefits, we will then be in a better position to maximise its use in teaching and to provide another path for learning for our pupils in a technology-rich environment.

Research Methodology

In this study, both a qualitative and a quantitative approach were used to analyse the data collected throughout the whole period. The qualitative information was obtained from written observational notes made during the process as well as from the pupils' written responses to two open-ended questions in the questionnaire (Appendix 1). At the evaluation

phase, the quantitative data was obtained. The item means were calculated based on the pupils' written responses to the 13 items in the questionnaire.

Sample

100 secondary 4 (aged 15-16) gifted male pupils were chosen for this study. They would be sitting for the GCE 'O' level chemistry at the end of 1998.

Research Plan

This study was carried out in five phases. A brief description of each phase is shown in Figure 1.

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Pre-planning 2 weeks	Planning 2 weeks	Exploratory 3 weeks	Consolidation 6 weeks	Completion 2 weeks	Evaluation 1-2 weeks

Figure 1: Phases of Research

During the pre-planning stage, the decision to integrate IT into the chemistry curriculum, and in particular, organic chemistry, was already stated in the workplan. Prior to the study of this topic, a brain storming session (based on Know, Think I Know, Want to Know) was carried out. At the end of the session, a lot of ideas were generated for discussion and placement. As a facilitator, the teacher worked out the areas/units that pupils could work on such as: petroleum, naming of organic compounds, alkanes, alkenes, alcohols, carboxylic acids, synthetic polymers and natural polymers. With the contact from the industries, the teacher also organised fieldtrips to various places such as Pulau Ayer Merbau (Polyolefin Company), Pulau Bukom (Shell Refinery) and Asia Breweries (fermentation) for the pupils to interact with the professionals in the fields Within the school, the computer facilities, the distribution of computer diskettes as well as the use of other resources such as the library and chemistry laboratories were also made available to them.

During the planning stage, the pupils were briefed about the nature of the task. The total time frame for working on the IT-based project was only three weeks (Two weeks before the March holidays and one week of the March school holidays). They formed groups of 4 or 5 pupils and they could choose one area/unit to explore. Within each group, the role played by each pupil was defined. For example, within the group, there would be an IT advisor (one who gives technical input such as the use of the Internet, computer programming, scanner and software), one coordinator (one who drafts plan, leads discussion group and coordinates work such as visits to the library and surfing the websites), one researcher (one who searches and organises materials) and one reporter (one who works with the researcher and reports the findings of the project). From literature search to data collection and analysis, the pupils made use of investigative skills to surf the Internet and extract relevant information to support and enhance their findings. In addition, project work of this nature also aimed to nurture pupils' interest in chemistry. They also met with their chemistry teacher to clarify their doubts or ask for assistance during chemistry lessons. The team-work and the ability to bounce off ideas with their peers and teachers sharpened their problem-solving skills and allowed for creativity and ingenuity.

During the consolidation phase, schedules of group presentations (about 10 minutes) were planned and conducted for about one and a half months (after the March holidays till the end of April). A mini-seminar which comprised of group presentation (10 minutes) cum question and answer session (5 minutes) was organised for the individual classes. During these sessions, observational notes were made. At the end of all the presentations, all the project diskettes were collected. All projects were evaluated based on the style of presentation, relevance of information as well as the use of graphics or media. The best project for each topic

was selected. Further refinement was also carried out in the selected work. For example, the modification of the words or graphics used and the incorporation of structured and multiple choice questions into each outstanding project. The IT-based lessons were prepared and were ready to be conducted in the computer laboratory with each unit loaded into each computer. There were a total of 8 units in 8 computer stations. A duplication of the topics was also found on the other half of the computer laboratory.

During the three periods of the IT-based lesson, the pupils worked in pairs to complete working on all 8 computer stations in the laboratory. They were also provided with the hard copies of worksheets for each station. They reviewed the IT presentation and completed the questions for each unit before moving on to the next station.

Before the completion stage, the teacher decided to further refine all 8 units. In other words, more quizzes, answers and explanations were included at the end of each topic. As a result, the limited memory space in the diskette (1.44Mb) could not even contain one topic and we had to resort to using a CD-ROM (650-680 Mb) for all the units of organic chemistry. The inexpensive cost of CD-ROM, the provision of CD recorder (Yamaha) and the CD-Writer programme (CeQuadrat) in the school's experimental laboratory made it possible for the teacher to make one for every pupil. Thus, a production team was formed to work on the making of the organic chemistry CD-ROM (Appendices 2 and 3). The whole process took about three weeks to complete. The CDs were distributed to pupils in July when they returned after their June vacation.

Evaluation of the use of organic chemistry CD-ROM was conducted at the end of July. The questionnaire was administered to the pupils during chemistry periods. The pupils took about one period to complete. The qualitative and quantitative data were obtained at this stage.

Data Collection

The 15-item questionnaire (Appendix 1) which consisted of two sections namely: Doing the IT- based organic chemistry project and Using the organic chemistry CD-ROM was administered to the pupils at the end of July. The pupils were asked to indicate the degree to which they disagreed or agreed with 13 items, on a 4-point scale from 'Strongly Disagree' or 'Very Poor' to 'Strongly Agree' or 'Very Good'. The remaining 2 descriptive questions came from each section of the questionnaire. The pupils' responses were collated at the end of the survey.

Results and discussion

The feedback was based on the 4 point Likert scale which pupils responded to. Table 1 shows the item means obtained for the first 6 statements in the questionnaire.

Table 1 Item Mean Score based on pupils' responses in doing the IT-based organic chemistry projects

Item No	Mean Scores
1	3.25
2	2.3
3	2.0
4	2.8
5	3.1
6	3.25

The results (Table 1) show an overall satisfaction with the IT-based group projects. The mean scores ranged from 2.0 (item 3) to 3.25 (items 1 and 6). Most of the pupils perceived doing an IT-based project to be positive learning experience. They also enjoyed working with their peers in producing their own IT-based work. With the effective use of colours, images

and other technologies, they could determine the extent of creative dimension to be added into their work. They also liked to make learning of chemical concepts interesting. As they worked with one another, they enjoyed the planning, searching for materials as well as the incorporation of graphics into their presentations. However, the lowest mean score obtained for item 3 indicated that most of them would like to have more freedom about the inclusion of materials for their projects. They wanted more freedom to decide what information to be included in their projects. Some pupils also suggested the possibility of expanding the scope of the projects and allow more flexibility in topics. This area could be further explored in the future IT-based projects.

The responses to the open-ended question in item 7 revealed that more time was needed for IT-based projects. Some pupils suggested that more advanced technical features such as video could be used to produce mixed media presentations. Other suggestions were the inclusion of encyclopedia and chemistry games.

Table 2 Item Mean Score based on Pupils' responses in using the organic chemistry CD-ROM

Item No	Mean Scores
8	3.5
9	2.85
10	2.9
11	3.1
12	3.15
13	3.8
14	3.2

The results in Table 2 show that the CD-ROM was relatively easy to use and the quality of the overall presentation was good. The lowest mean score obtained in item 9 revealed that informational retrieval was difficult. Some students suggested the integration of the tool bar. With regards to the qualitative question number 15, one of the pupils suggested having more information, including a single menu to integrate presentations or a find function. The inclusion of more multimedia and more interaction showed that MS Powerpoint has its limitation in this aspect. Therefore, Director 6 will be strongly recommended. The autostart feature from MS Powerpoint Viewer could be included in this CD-ROM for users to run the content of the CD without having to install MS Powerpoint.

Conclusion

This project was highly rewarding in that pupils learnt more about the integration of IT into chemistry learning and are more likely to expand its use in the future.The findings indicate that the use of IT-based projects could be used effectively for small groups, large groups and for individualised instruction. Small groups (IT-based group projects) allowed good participation and the individualised approach good for self-pacing such as using the customised chemistry CD-ROM. Large groups would enjoy the learning experience through a new and different kind of interaction. We must also make clear that although using technology can make learning more fun and interesting it is not meant to replace conventional instruction totally. In fact the use of IT in teaching and learning transforms the classrooms into a mix of traditional and non-traditional setting which also changes the teaching style and the learning style of pupils. The teacher's role as a facilitator is still very important in guiding the pupils to realise their potentials. The incorporation of IT into the curriculum serves to add on another dimension to learning for our pupils who will be our valuable resources in the future.

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Appendix 1

Questionnaire on Developing and Using Customised Organic Chemistry CD-ROM

This questionnaire consists of two sections:

A Doing IT-based Organic Chemistry Project
B Using the Organic Chemistry CD-ROM

You are to complete all the items in this questionnaire.

A	**Doing IT-based Organic Chemistry Project**	**SD**	**D**	**A**	**SA**
1	This project was a meaningful/ positive experience.	( )	( )	( )	( )
2	This project required a lot of our time.	( )	( )	( )	( )
3	This project gave us freedom to decide what information to be included.	( )	( )	( )	( )

4	This project gave us an opportunity to use the Internet as an information resource effectively.	( )	( )	( )	( )
5	This project gave us an opportunity to explore different technologies available to us.	( )	( )	( )	( )
6	This project gave us an opportunity to produce IT-based academic group work.	( )	( )	( )	( )
7	How can the project be improved?				

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B	**Using the Organic Chemistry CD-ROM**	**V.Poor**	**Poor**	**Good**	**V.Good**
8	Ease of use	( )	( )	( )	( )
9	Information retrieval and searching	( )	( )	( )	( )
10	Interactivity	( )	( )	( )	( )
11	Usefulness in self-learning	( )	( )	( )	( )
12	Use of media / multimedia	( )	( )	( )	( )
13	Quality of presentation	( )	( )	( )	( )
14	Accuracy of information	( )	( )	( )	( )
15	How can the Organic Chemistry CD-ROM be improved?				

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Appendix 2

Using CeQuadrat- CD Writer Programme

1 Copy files into hard disk.
2 Start CeQuadrat Wizard
3 Select data CD
4 Click *Next*
5 At 1 highlight the directory, the content of the directory should appear at *2*
6 Highlight all files in no.2, drag and drop into no. *3*
7 To burn CD, click *Next*, choose fast setting
8 Click *Record*

Appendix 3

How to create the Index in this presentation

Go to Andyart at www.andyart.com and look in the 'vault' for free images or Using Photoshop

1. Create a square canvas.
   Hold on the selection button to open a selection, then choose

2. Use Alt, Shift and Ctrl to guide you in making a circular selection slightly
   off to the top left. Select a desired colour.

3. Fill the selection with the fill tool.

4. Go to the filters menu and select 'render', then 'lighting effects'
   Adjust the position of the light source and angle
   Now click on the new layer button

5. Using the elliptical selection tool, select an oval section to use as the shadow.
   Do not use Alt, Shift and Ctrl as you want an oval not a circle.
   *Before selection, go to tools/options and set 'feather' to > 2.
   Change the colour to black and select the fill tool.

6. Fill the oval with black. Now hold down to the shadow layers menu and drag it behind
   or lower down than the sphere. Adjust the capacity setting to about 75%.