Computer Graphics in ESL Student Learning of Language and Content: A Case Study

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Abstract: This paper describes the procedure of a course which integrates the teaching of academic English, science content knowledge, and computer skills. It reports on the student learning outcomes and discusses the role of computer graphics in ESL student learning of language and content at the secondary level. The course, conducted in a com puter laboratory in a school in Vancouver, was based on the Knowledge Framework (Mohan 1986) and the goal was to provide opportunities for the ESL students' academic and cognitive development to continue while they were In the process of acquiring academic English.
Observations and Interviews yielded results which indicate (1) that computer graphics aid ESL student learning of academic language and content, (2) that ESL students are capable of acquiring computer skills, academic knowledge, and academic English simultaneously in the computer laboratory, and (3) that the computer laboratory provides a facilitative, non-threatening environment for ESL students' language socialization and acculturation. Further research is recommended.

Resume: Cet expos6 decrit la procedure d'un cours qui integre i'enseignement de l'anglals conventlonnel, lesconnalssancesdessciencesetderinformatlque, Ilrendcomptedesresultats de l'etudiant et examine le role de I'informatique graphique dans I'apprentlssage de l'anglals tongue seconde (ESL) et son contenu au niveau secondaire. Le cours, dlrlg6 dans un laboratolre Informatique dans une ecole a Vancouver, etalt base sur le Knowledge Framework (Mohan 1986) et permettait aux etudlants d'anglais langue seconde d'apprendre I'anglais tout en poursuivant leur evolution academlque et cognitive.

Les resulfats d'observations et d'entrevues indlquent que premlerement, I'informatique aide les etudlants en anglais langue seconde d apprendre la langue academlque et son contenu, deuxlemement, ces etudlants sont capable d'acquerir les techniques de I'informatique, les connalssances academiques et I'anglals simultanement dans le laboratoire de I'informatique, et trolsiement, le laboratoire de I'informatique procure aux etudlants un environnement accessible et non menacant pour la socialisation et 1'acculturation. Des techerches additlonnelles sont recommandees.

PURPOSE OF THE STUDY

This paper reports on the findings of a case study (Merriam 1985) conducted in a multicultural class in a secondary school in Vancouver. It describes the procedure and results of a teacher's successful attempt to integrate the teaching of computer skills, academic language, and content knowledge through computer graphics in an English as a second language (ESL) class.

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The objectives of the enquiry were (1) to discover whether or not computer graphics aid ESL student learning of language and content in a specific situation and (2) to evaluate the degree of success of a course which integrated the teaching of language and content and computer literacy.

Multicultural classes have become a common phenomenon in many Canadian schools because of the influx of recent immigrants from different parts of the world. Immigrant or ESL students are usually placed in ESL classes until they are linguistically ready to join their English-speaking peers in content classes. However, research findings show that the development of the "academic aspects of language proficiency involves a complex array of linguistic competencies" (Cummins 1989, p. 32), that it is a long-term process, and that it takes from 4 to 8 years (Collier 1987) for ESL students to reach native-speaker levels of academic language proficiency. This means that ESL students are denied equal opportunities to access content knowledge for a long time. It is, thus, imperative that ESL students be allowed to access academic knowledge and develop their cognitive skills while they are in the process of acquiring academic English proficiency. This paper examines a course which addresses this issue.

An underlying assumption of this study is schema theory (Bartlett 1932; Carrell 1983), which maintains that understanding knowledge expressed in spoken or written language requires students to be able to relate new knowledge to prior knowledge. For students who join an English-speaking school system for the first time, prior knowledge is defined as the sum total of the experiences the students bring with them from their home country. How can ESL students' prior knowledge be activated by English-speaking teachers in English-medium classes? This paper explores the feasibility of using computer graphics to activate prior knowledge. Another issue addressed in this paper is language socialization. In order that ESL students will learn as comfortably as their English-speaking peers in class, some educators feel that ESL students should be initiated into the social practices, the academic language functions, and the culture of the English-speaking classroom.

A possible answer to the above concerns is to design courses which integrate the teaching of academic language, content, and learning tools/strategies which are common across languages, e.g., graphics. This paper reports on one such course, a course in which the teacher used computer graphics (1) to teach content knowledge, (2) to access ESL students' background knowledge, and (3) to initiate the ESL students into the academic language functions of the English-speaking classroom.

THE CASE STUDY

The Participants of the Study

This case study (Merriam 1985) describes an on-going science course conducted in the setting of a Macintosh laboratory in a secondary school in Vancouver. I observed 26 lessons over a period of eight weeks, interviewed the students and teacher, and examined the students' assignments.

The class was made up of 15 recent immigrant students, six boys and nine girls. The students were from various countries: India, Nicaragua, El Salvador, China, Hong Kong and Vietnam. They spoke a variety of languages. Their length of residence in Canada ranged from two months to three years. All the students, with the exception of one boy from Hong Kong, could communicate in English. However, the students had difficulty with the academic language demands of the curriculum. The content of the course was new to most of the students. Only two of them had encountered some of the topics in their first language. They assured me that they could vaguely recall a little of the knowledge. Three of them, who had attended another course in the Macintosh Laboratory, had acquired some computer skills; the others had none. None of the students in this group had received any training in computer literacy before they came to their present school.

Philosophy and Theoretical Framework

The Course Observed

The course was part of a large-scale project, the Vancouver School Board Language and Content Project (Early, Mohian & Hooper 1989). The project was mounted jointly by the Vancouver School Board and the Language Education Department at the University of British Columbia to increase the academic achievement of those students classified as ESL or low English proficiency students. The aim of the project was to enable ESL students to acquire the academic and cognitive skills needed in content area classrooms so that they would be able to enjoy the full benefits of education. It was concerned with "the language barrier to academic achievement for ESL students and with methods of implementing coordinated language learning to reduce this barrier" (Early et al. 1989, p. 107). It was based on the Knowledge Framework (Mohan 1986), an organizing framework for integrating language and content. A brief overview of the Knowledge Framework follows.

The Knowledge Framework

According to Mohan (1986), there are certain knowledge structures which are common across subject areas. These structures can be used to integrate the teaching of academic language and content across the curriculum. Knowledge structures include classification, principles, evaluation, description, temporal sequence, and choice/decision making (see Figure 1). They are rhetorical patterns found in discourse. These structures are common across languages and cultures. They can be defined as thinking skills realized in the macrostructure of written text and oral discourse as well as in graphic form. These thinking skills are the same thinking skills listed in the learning objectives of various elementary and secondary school curricula. Some examples of the thinking skills associated with each knowledge structure are shown in Figure 1.

Each knowledge structure has a specific set of linguistic and cohesive devices (e.g., First,.. Next,.. Then,.. Finally are devices which characterize a sequence) and a list of graphic representations. Using the Knowledge Framework to organize the teaching of content enables the teacher to systematically develop language skills and content knowledge in ESL students. The Knowledge Framework also helps students to transfer learning across subject areas. For example, students can transfer the learning of classification from classifying flowering and non-flowering plants in Biology to classifying imports and exports in Social Studies. In other words, the Knowledge Framework is an organizing framework which helps in the encoding and retrieval of knowledge (Rieber 1989). Graphic representations of knowledge structures, on the other hand, are schemata which assist learning across languages and cultures. They also lower the language barrier for ESL students.

Figure 1.
The Knowledge Framework and Related Thinking Skills.

CLASSIFICATION	PRINCIPLES/ CAUSE-EFFECT	EVLAUATION
Classifying Categorizing Defining	Relating cause and effect Generalizing Drawing conclusions	Criticizing Justifying Evaluating
Naming Comparing and contrasting Describing	Following instructions/procedures Arranging information in chronological order	Stating preference Making decisions Recommending
DESCRIPTION	TEMPORAL SEQUENCE	CHOICE/ DECISION MAKING

Graphic Representation of Knowledge Structure

Knowledge structures can also be presented in a graphic form. There are specific graphic forms for each knowledge structure, e.g., a tree for classification, and a timeline for sequence. Graphic forms and graphic conventions of textbook illustrations have been found to be common across content areas and across languages and cultures (Tang, in progress). Graphics might have the potential for eliciting students' background knowledge acquired in their first language. Recent research results indicate that graphics can enhance ESL student learning of content knowledge and language (Tang 1992). However, findings of ethnographic studies show that students tend to skip over graphics and textbook illustrations or give very little attention to diagrams in instructional materials (Evans, Watson & Willows 1987; Tang 1991b). To make sure that students pay attention to graphics, it is necessary to ensure that the graphics in instructional materials are interactive. Textbook or printed graphics are static, but computer graphics can be dynamic and interactive. Results of research in computer graphics have been positive and have provided some support for using computer graphics in instruction (Alesandrini 1987). Rieber"s (1990) studies have yielded findings which suggest that animated presentations can promote the learning of science concepts in English-speaking students under certain conditions. This study attempts to discover whether or not computer graphics can enhance the learning of science concepts in secondary ESL students.

Description of the Course

Structure of the Course

The course observed was a beginner ESL science course specifically designed for ESL students who found the academic language of science demanding. The subject matter was based on the textbook used by regular classes. The teacher had reorganized and rewritten the materials for the Macintosh Classic microcomputer. The aims of the course were threefold: the teaching of academic English through content, the teaching of science concepts, and the teaching of computer literacy. Greater emphasis was put on computer literacy (60%) than on science concepts (40%). The teacher integrated language and content: he was teaching computer literacy through science, science through the computer, and English through science and computer literacy. He employed the Knowledge Framework to organize his lessons and to effect the integration of language and content. While presenting science knowledge, the teacher systematically drew the students' attention to the linguistic devices of a particular knowledge structure, e.g., sequence or classification. He also used graphic representations to lower the language barrier for the students, to enhance the visual impact, to elicit background knowledge, and to make the links in the integration.

In lesson preparation, the teacher consulted the textbook and reference materials on the same topic and either transferred or created instructional materials on HyperCard for Macintosh computers. HyperCard is a software tool which "provides new ways to organize, display, and navigate through information. And it gives non-programmers the capability to design and write their own applications" (Markman 1988, p. 333). It allows the user to customize information, to modify existing stacks, to illustrate them, to copy information from one stack into another and to "peer behind the buttons to see and modify the scripts that make them work" (Markman 1988, p. 335). Classroom tasks included creating cards (computer skill), copying a diagram on the card (computer and content), labelling a diagram (content and language), and writing a paragraph based on the diagram (language and content). The end product was a stack of cards which the students had made on the computer showing (1) the knowledge they had acquired regarding life functions and (2) the language they had learned to use to demonstrate their knowledge.

The Macintosh Laboratory

Fifteen Macintosh Classic machines were connected to a server in a network. The microcomputers were arranged so that the students sat with their backs to the teacher. While giving an explanation, the teacher could observe the computer screen rather than the students' facial expressions. According to the teacher, the screens provide more information on the students' understanding and ability to follow instructions than their facial expressions do. The screen of the teacher's machine was connected to a projection unit that sat on an overhead projector. Each student was assigned a machine and given a three-and-a-half-inch diskette which they were to use throughout the course.

Lesson Procedure

In the first lesson, the teacher introduced the students to HyperCard. He explained that HyperCard was a software program that was made up of a 'stack' of screens or, in the program's metaphor, "cards" arranged one behind another. He explained the use of the diskette, and he familiarized the students with the computer screen by drawing their attention to some of the functions listed on the screen, such as Tools, Objects, and Files.

In subsequent lessons in which he presented computer skills and content knowledge through the computer, the teacher followed the same pattern with minor variations in each lesson. The instructional sequence is outlined below.

1. The teacher gathered all the students to the front of the room, near his computer and the chalkboards. He presented content information by drawing a graphic, such as a diagram of the digestive system, on the chalkboard. He used graphics and questions to elicit background information and he built background knowledge by presenting the information orally with the help of chalkboard diagrams and written or oral texts.
2. He then projected his computer screen on the overhead projector. Usually the projector showed the same graphic as the one he had drawn on the chalkboard. The repetition of the image was for reinforcement and for linking the computer graphic to the drawing on the chalkboard.
3. He explained the computer tasks and demonstrated on his computer the process from beginning to the end. For example, he said, "Go to File, click and hold, go to New Stack and let go. Click on Field tool. *Go to* Objects, click and hold, go to New Field and let go." The computer screen was projected on the overhead screen.
4. When the task had been successfully completed, he went to one of the students' computers and demonstrated the steps of the task over again while he verbalized all the steps and asked occasional questions.
5. The students then went to their own computers to perform the computer task that had been demonstrated twice. The students were encouraged to discuss the procedure with a neighbour. Meanwhile, the teacher gave individual help when necessary.
6. The students performed an assigned content task which involved copying text passages, constructing text passages, labelling diagrams, or answering questions.

7. When the students had finished the task, they reported to the teacher who would then check each student's work and give immediate feedback.

Computer Tasks

The computer skills which the students were expected to learn included the following:

- accessing a program on the microcomputer,
- demonstrating on-screen text and icon applications,
- accessing a file,
- demonstrating typing and drawing,
- moving the mouse,
- creating and accessing a card,
- making, naming, and moving buttons of various shapes, sizes, and types,
- making and manipulating fields,
- choosing desirable fonts,
- converting teacher's file to own file,
- typing in simple programs,
- demonstrating the working of the programs.

Language and Content Tasks

The teacher integrated the teaching of language and content in various ways. For example, he taught science concepts by using the language of sequence and, at the same time, he taught the language of sequence by discussing the human digestive system. In presenting the different steps of copying a card, making a button, or writing a script, he used the language of sequence. Consequently, the Knowledge Framework was the device which effected the link among computer skills, science knowledge, and academic language.

The subject discipline was science and the topic was life functions. Students were expected to learn the parts and functions of various systems including the respiratory system and the processes of life functions such as digestion and blood circulation, and principles such as response to stimuli. In the presentation of knowledge, the teacher made use of graphics both on the chalkboard and on the computer screen. He was aware of the principal knowledge structure of each phase of instruction and used the language items characteristic of that knowledge structure.

The tasks which the students had to perform and the knowledge which they were expected to acquire included labelling diagrams, filling in blanks, completing charts, constructing sentences to show cause-effect, and writing paragraphs to show sequence of events (see Figure 2). The tasks set on the same topic were related. Each task was based on a graphic and built on a previous task.

For example, they had to label a diagram of the respiratory system. Then the students had to make a chart, to sort, to sequence, and to write down the name and functions of each part of the system beginning from the nasal cavity. The next task was to write a paragraph based on the information in the graphic they had just completed entitled Respiration, following the path of air from the nasal cavity to the lungs and out again. Before the students started writing, the teacher told

Figure 2.
Examples of Computer Graphics with which Students Interacted.

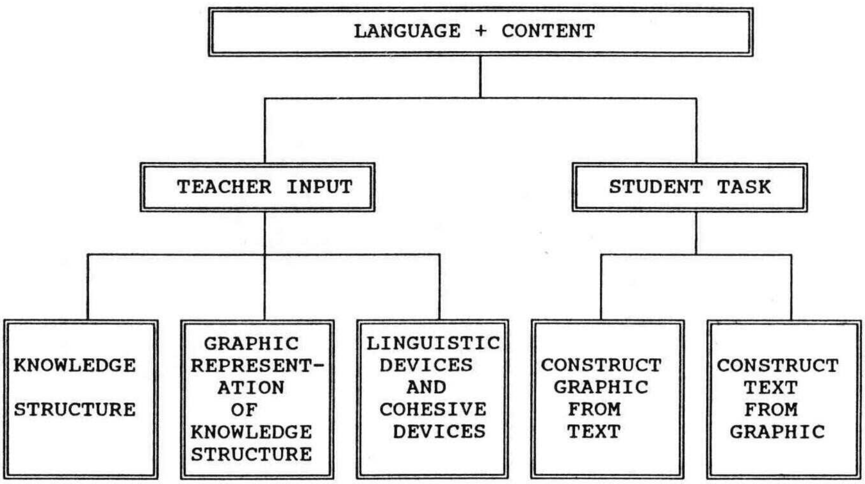
Type	Form	Topic	KS	Tasks
LIFE FUNCTIONS |				
Abs	Chart	Life functions	Cl	1. Make table of content by creating and stacking buttons. 2. Label buttons.
INGESTION |				
Rep	Picture	Ingestion in animals and plants	P	1 . Draw pictures, draw arrows, label pictures. 2. Write paragraph to explain picture.
DIGESTION |				
Ana	Diagram	Human digestive system	S	1 . Learn sequential order of organs. 2. Label organs.
Abs	Chart	Digestive system	C1	1 . Create chart. 2. Put organs of the digestive system in sequence. 3. Complete chart by filling in functions of each organ.
Abs	Pictorial	Journey of a hot dog through the digestive system	S	1 . Study chart. 2. Write a paragraph based on the information in the chart.
[RESPONSE TO STIMULI |				
Ana	Diagram	Response to stimuli	P	1. Draw eye. 2. Type program. 3. Demonstrate how the program works.
Abs	Chart	Response to stimuli	P	1 . Create chart. 2. Write sentences showing cause-effect.

Type: Representational (Rep)
Analogical (Ana)
Abstract (Abs)

Knowledge Structures (KS): Description (D)
Classification (Cl)
Sequence (S)
Principles (P)

them explicitly that the paragraph involved writing about a process and that there were special linguistic devices for that type of writing. While going over the passage of air through the respiratory system, he put the linguistic devices of sequence on the chalkboard, e.g., When air enters.first it goes... Then it passes... Next... etc. He further instructed them to try to use those terms in their paragraph. In short, the teacher was following a classroom model of instruction (see Figure 3) which has been found to have positive effects on ESL student learning of language and content (Tang 1991a).

Figure 3.
A Classroom Model.



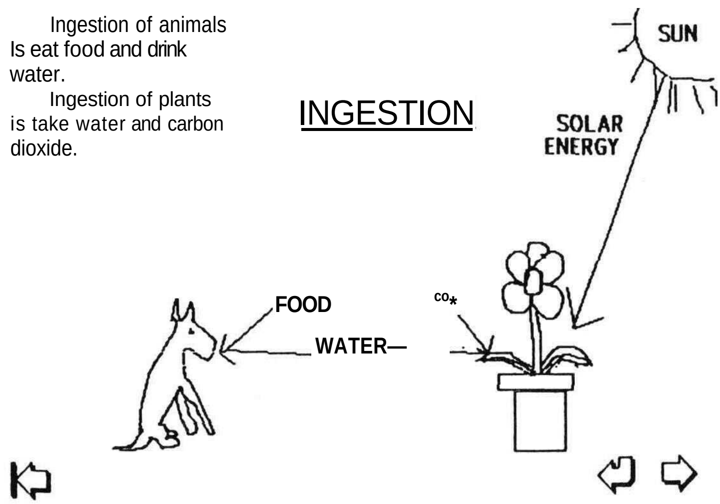
FINDINGS OF THE CASE STUDY

Computer Graphics

Computer Graphic Types with which Students Interacted

Observation of the lessons showed that every concept in science could be visualized and all illustrations found in printed materials could be shown on the computer screen. Representational pictures (Levie&Lentz 1982)which had been scanned from reference books, analogical graphics (Alesandrini 1987) such as representations of the digestive system and abstract graphics (Alesandrini 1987) such as tree graphs, classification charts, and sequence diagrams were used to illustrate new concepts and to elicit student writing. They were either teacher-provided or student-generated. Figure 4 is an example of a student-generated graphic.

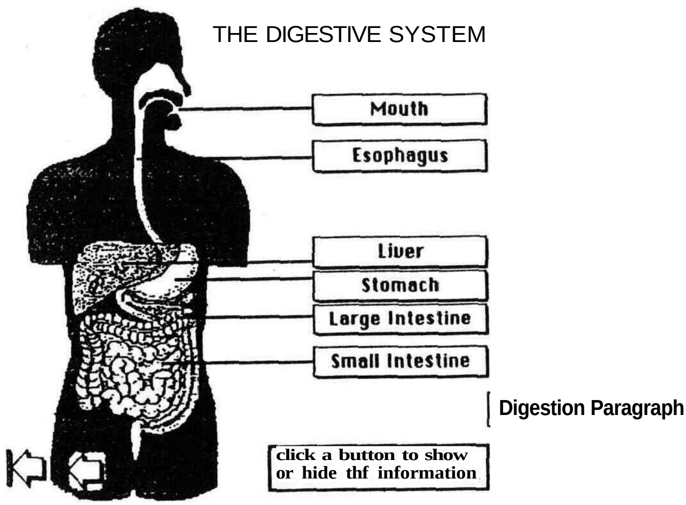
Figure 4.
Student-Generated Graphics.



Some of the graphics were static; others were dynamic and interactive. The static graphics were textbook illustrations (see Figure 5) on screen which could appear or disappear at the click of the mouse or the touch of a key or two. Some of the diagrams and charts used for labelling and completion exercises were similar to printed worksheets. The difference between printed and computer graphics was that the desired page, or the desired section of a page with the definition of the term could be accessed by clicking on a button with a label, e.g., small intestine (see Figure 5). Another difference was that the cells in the computer chart could scroll. Consequently, writing did not have to be constrained by the size of the cell.

An animation is a type of graphic which could only appear on a screen. It was produced by writing a program and could be designed to be interactive. For example, in creating visuals to show the principle of response to stimuli, the students had to make three cards and draw three versions of the same picture, such as an eye with a different-sized pupil. They then had to create buttons and write a short program so that by clicking on a button, they could demonstrate how the size of the pupil responds to different intensities of light (see Figure 6).

Figure 5.
The Digestive System.

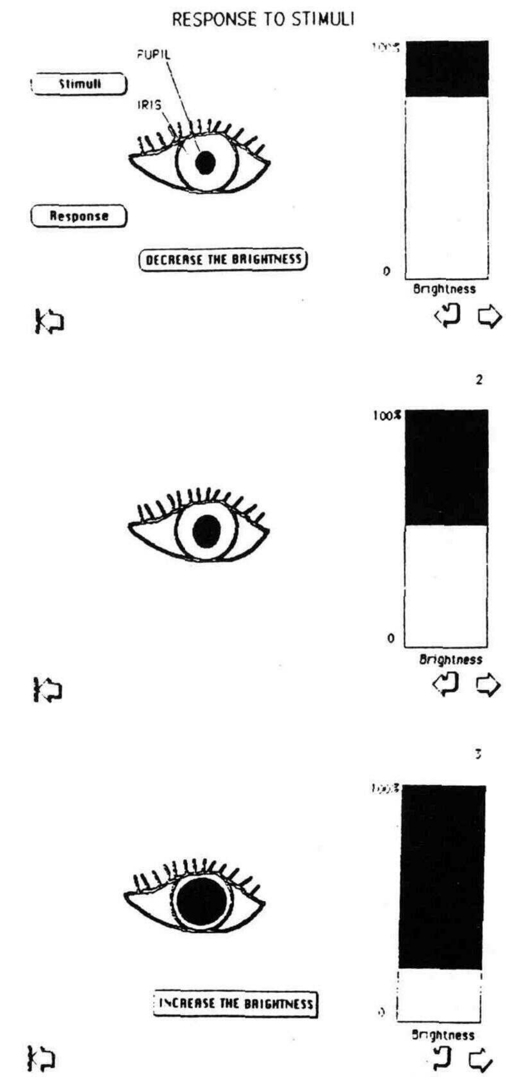


Examples of the graphic types with which the students had to interact and the tasks they had to perform are shown in Figure *2*. In short, the students interacted with a large quantity and variety of graphics. Each was a representation of a knowledge structure.

How Students Interacted with Computer Graphics

The students interacted with graphics in different ways: labelling diagrams, filling in blanks, describing, explaining processes, interpreting principles, copying pictures, creating charts, and drawing pictures. Their attention was directed to the graphics and all assignments were based on one or two graphics. Thus, while doing their assignment, they kept going back to the graphic to look for additional information. Sometimes the students were forced to refer to the computer graphic because it was the only one available. Other times the students chose the computer graphic instead of the one in the textbook. However, when the same graphic appeared on the chalkboard and computer screen, equal number of students referred to the chalkboard as to the screen.

Figure 6.
An Animation.



Discussion on the Effect of Computer Graphics on ESL Student Learning

Language and Content

Oral interviews and examination of the students' written work showed that all the students could understand the concepts presented when the teacher employed graphic representation of knowledge structures to present content knowledge. They showed understanding of the processes of the various life functions; of the cause-effect relation of stimulus and response; and of the functions of the systems learned. They could also express in short paragraphs their understanding of the information, such as the digestion of a hot dog and the functions of various organs. It was evident from interviews and questioning that the students could recall the information from their short-term memory. However, how long the students could retain the knowledge and how much of the knowledge could be retained was not investigated. Future research is recommended.

The representational pictures which showed the cycle of ingestion helped them to understand the principles of ingestion. The labelled diagrams of the various systems enabled them to understand the sequential order of the organs in a system and how the system works. The chart of the functions of each organ helped them to write a paragraph because the organs were arranged in the right order and because the functions appeared alongside the organ. They could, thus, produce a paragraph by copying some phrases from the chart and linking them by the linguistic and cohesive devices, e.g., First . . . Next . . . and Then. . ., suggested by the teacher.

Questions on the information which had been represented as computer graphics were more readily answered than questions which required the students to read a passage or to look for a picture in a book. By clicking the mouse, they accessed the right picture, looked at the chart and without much difficulty knew the right phrase to choose. In this respect, a computer graphic had advantage over a textbook graphic. The students were aware of the advantage, i.e., convenience of access, and made use of it. However, the graphic type in which the students were most interested and the one which was most attention-getting was the animation. An example follows.

The graphic which explained the principle of response to stimuli was created by a simple program. It was interactive and it made the concept easier to understand. After looking at the picture, clicking on the button increases the brightness, and watching the picture of the pupil become smaller, all the students could explain the principle of how the pupil responds to light. Some of their responses were:

> "When I am in the darker place, the pupil will change it smaller."
> "When I turn on the light, the pupil goes small. If there is little light the pupil goes bigger." and
> "When we get into bright room, the pupil will be smaller when we go into dark room the pupil will be bigger."

Even the student who could not quite explain it in English readily told me in Cantonese what the graphic showed. Furthermore, the graphic seemed to be able to hold their attention for a long time. Thus, "presenting information on a computer, particularly in an interactive format, seems to have some useful motivational and attention attracting characteristics" (Reynolds & Baker 1987, p. 172) for ESL students. Of all the graphics presented in the course, this was the most attention attracting. In the program, they changed the wait time from 50 (computer time units) to 30 several times for fun and to test how quickly one picture dissolved into the next (see Figure 7). It appears that "it is this dynamic and interactive aspect of computer graphics that is so appealing to learners (Alesandrini 1987, p. 159) and holds great promise for facilitating ESL student learning. However, the value of this graphic should not be overstated on the evidence of one example. Rieber (1990) points out that "given the track record of animation research, the efficacy of animation as a presentation variable is obviously very subtle and difficult to draw out" (Rieber 1990, p. 139) and that animated presentations can promote learning only under certain conditions. Further investigation is needed to establish the value of animations in ESL student learning.

Figure 7.
A Computer Program.

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On mouse up
Repeat 2 times
Visual effect dissolve
Go next
Wait 50
Ends repeat
End mouseup

On mouseup
Repeat 2
Visual effect dissolve
Go back
Ends repeat
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Linguistically they had learned or were learning to write a paragraph showing the sequence of events and to answer questions showing cause-effect relations, and so forth. It is true that there were mistakes in their writing and speaking, but they were cohesive texts because all students attempted to use the linguistic and cohesive devices the teacher had emphasized. This finding supports my conjecture that linguistic devices characteristic of a knowledge structure have to be explicitly taught (Tang 199 la) and Long's (in press) assertion that learning of form is enhanced if learners' attention is drawn to it. Some samples of the students' first drafts are shown in Figure 8. The final drafts were almost perfect in accuracy because the students were alerted to errors and inaccuracies during individual conferencing when the teacher provided immediate feedback.

Figure 8.
Students'Paragraph Writing.

Nancy's Respiration Paragraph

When I inhale the air, it enter my Nasal Cavity to breath in oxygen and it passes through to the pharynx. The it goes to Epiglottis, from the Epiglottis it moves down to the larynx and that the air goes to my Trachea. Then from the Trachea it goes to the Bronchi and the airs spreads out all through the lungs into the Alveoli. The oxygen from the air it goes to the alveoli. From the lungs.

Kristina's Respiration Paragraph

When air inhaling, it enter to my nasal cavity, air passes through the pharynx. Next the epiglottis open to let air go to larynx and passes through the trachea. Aflerthisitgodowntobronchi. Then it spreads out all through the lungs. It goes to alveoli.

Activating Prior Knowledge

Did computer graphics help the ESL students to access prior knowledge acquired in their first language? Interviews with the students showed that they recognized universal or common graphics such as diagrams of the digestive system, circulatory system, and graphics showing the principle of photosynthesis. The students from Hong Kong were able to tell me in Cantonese what the diagrams were about, e.g., "This is the process called photosynthesis. Plants take in carbon dioxide and water and sunlight. They make sugar and oxygen." Another student could tell me in Cantonese that the diagram was about blood circulation. He guessed the meaning of "Vein" and "artery" in Cantonese because he had seen the diagram before. However, he could neither pronounce the words nor express in English what the diagram described. It is difficult to decide whether and how much schema (Carrell 1983) or prior knowledge learned in their first language affected their learning. I noticed that for one of the students, a familiar diagram or chart was like a key word. Whatever the question, his response was the same. For example, the respiratory system invariably elicited the ready response, "Breathe in oxygen and breathe out carbon dioxide." From time to time, he volunteered an unexpected answer translated directly from Cantonese which was grammatically incorrect but which might make good sense.

Computer Literacy

All the students became computer literate in varying degrees. The amount they learned and retained depended on the individual student. Beginners who had never touched a computer before the first class of this course sought individual help throughout. However, at the end of the eight-week period, all the students had a completed stack of cards to show and tell. They could do all the basic tasks such as starting up and shuttingdown, moving from card to card using command keys or the mouse, typing, changing font size and type face, and erasing. They could make line drawings to decorate their cards and they could change special effect specifications which, according to them, was like magic. They seemed more interested in the latter because of its interactive characteristic. Some of them could verbalize the procedure. An example follows:

> At first I put a program into this button. And then the button will do what I type. Will do what the program say. The pupil will bigger or this table will be the brightness grow more or little. When you click this button the pupil will smaller and the dark will smaller too.

A very highly motivated student who wanted to outperform his classmates could remember everything. He remembered how to create new buttons, a task which most beginners did not. He even attempted to do something extra to his program to impress the teacher. Those who had attended another course in the computer laboratory in the previous terms could remember all the tasks taught. However, none of them could trouble shoot. If anything unexpected turned up, e.g., a blank chart appeared instead of a completed one, they were perplexed. Nevertheless, it can safely be concluded that all students in this course had become computer literate in varying degrees. They did not exhibit any computer fear and some would like to take another course to become more proficient in computer skills.

Attitude, Language Socialization and Acculturation

All the students found going to the computer laboratory much more interesting than having classes in the classroom. The three non-beginners loved the computer. They liked to improve their computer skills and one of them seemed interested in trying out new skills. He kept asking questions about using the scanner. Most of the beginners were not as comfortable with the computer: they were bewildered by the scrolling field and found the terms Card, Field, and Button confusing. However, they were proud to be able to do what they had learned, particularly the special effects. Towards the end of the course, all the students expressed interest in taking computer courses.

The students who had taken a typing course found it easier to write on the computer than on paper. All were aware of the strength of the computer as a writing tool: it made editing, changing, and rewriting their paragraphs easier. A student from Hong Kong recalled what he had to do back home when he made a mistake in his essay writing; he had to recopy the entire essay. He preferred doing corrections on the computer. Another student who did not like drawing on paper liked drawing on the computer.

Computer graphics appeared to have the potential for effecting language socialization: they played a part in initiating the ESL students into the social practices or academic language functions of the English-speaking classroom. These practices included listening to and reading academic discourse to comprehend knowledge and speaking and writing academic discourse to express content knowledge.

What was most remarkable was the initiation of ESL students into the culture of the Canadian classroom. The atmosphere the teacher had created was friendly and non-threatening. The students soon learned to respond to and enjoy the teacher's sense of humour, and anticipated a joke on the screen, e.g., "Task one. Smile to your teacher." or "Your teacher is a great guy."

All the students seemed willing to communicate with their peers, including those who spoke a different first language. The setting of the laboratory was more conducive to student-student interaction. In the class observed, the students who were more proficient in English and who were often the only students to contribute in class were not the best in computer literacy, and some of those who were usually too afraid to make mistakes and speak in class were more proficient in computer skills. Often the quiet students gave instructions to the less quiet ones. This reversal of roles gave the usually quiet students a chance to gain self-confidence and self-esteem.

Generally, the students were willing to ask questions, to initiate dialogue with the teacher, to engage in group discussion, and to cooperate with their classmates in problem solving. Though the question was not investigated, the non-threatening and friendly atmosphere of the computer laboratory appeared to have helped in the socialization of the ESL students into the culture and academic and social practices of the Canadian classroom. It would be worthwhile to conduct further research to address this question.

SUMMARY AND CONCLUSION

Findings of the study show that computer graphics, both static pictures and animations, have the potential for aiding ESL student learning of science concepts. There are indications that the animation can hold students' attention for the longest time, supporting Rieber's (1991) assertion that animation is an effective attention gaining device. However, results show no evidence that one type of graphic is more facilitative of learning than the other. There are also indications that computer graphics can activate some of the students' prior knowledge acquired in their first language, but the question needs further investigation. It is also difficult to determine how much of the student learning is affected by the computer graphics. Nevertheless, taken globally, the ESL science course appears to have succeeded in attaining its objectives.

The students understood all the science concepts presented (content learning). They could express their understanding in oral and written form (academic language learning). They were also learning to write paragraphs using the linguistic and cohesive devices of different knowledge structures (awareness of knowledge structures). They had to perform tasks which involved classification, description, principles, sequence, evaluation, and choice (the Knowledge Framework). Moreover, they became computer literate in varying degrees (computer skills). These findings indicate that the Knowledge Framework is a useful device for teaching and integrating the instruction of science concepts, academic language and computer skills. Besides, students' attitude towards the course was positive. Furthermore, the atmosphere the teacher created helped to initiate the students into the cultural and social practices of the Canadian classroom.

However, this paper has described only one slice of life of one classroom within a limited time frame. It has shown only one course which integrates language, content, and computer studies. It is one person's construction of the reality of one case and is expected to be read as such.

Finally, further research in similar courses which integrate language, content, and computer skills is needed; and studies for investigating computer graphics and the long-term retention of knowledge and use of language are warranted.

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