COMPUTERS AND CONTENT-BASED LANGUAGE LEARNING

by

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Abstract

Can a computer database be used to augment a content-based approach to developing academic discourse? This document reports on the integration of these three areas in student tasks in a unit of work (biology) taught by a content teacher and a language specialist to a class of grade 7 students in a Vancouver elementary school. The objectives of the study were 1) to investigate the connections between biology content, the academic discourse of classification and a computer database, and 2) to identify if each area was in fact related to the knowledge structures of classification and description. The research method focussed on ethnographic observations, interviews and recordings of the students and the teachers as they worked through the unit. Analysis of the findings seems to suggest that there are connections between biology content, academic discourse of classification and a computer database, and that each area is related to the knowledge structure of classification and description. This finding further suggests that student tasks at the computer have the potential for developing academic discourse and the learning of content. This potential may deserve further investigation by both teachers and researchers.
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Chapter 1

COMPUTERS AND CONTENT-BASED LANGUAGE LEARNING

The Vancouver School Board (VSB) having recognized the need for English as a second language (ESL) students to develop their language proficiency and increase their academic achievement has initiated a large scale research and curriculum project based on Mohan's integrative language and content learning across the curriculum approach. A major focus of this project is to investigate the means by which ESL students can increase their academic achievement and their language proficiency.

THE QUESTION

One hypothesized means proposed for increasing language proficiency and academic achievement in the project is to use a computer database as a bridge between language and content and as a means for supporting cognitive/academic development. However before going to this point it is necessary to ask the general question if connections exist between content, computers and language. To answer this question it is necessary to ask a particular question. Are the underlying organizational patterns of content - the classification of vertebrates, a computer application - a database program, and language - the academic discourse of classification related to the knowledge structures of classification and description? If this question can be answered yes, then a foundation has been set for investigating the potential for using a database as described above.
BACKGROUND TO THE QUESTION

The Vancouver School district enrolls the largest ESL student group in the province of British Columbia. The most recent VSB survey shows that 47% of the student population speaks English as a second language. Recent research suggests that it requires ESL students anywhere from 4-8 years to reach grade level norms in core academic courses. Many researchers attest that ESL students do not live up to their academic potential. ESL students face many difficulties when it comes to coping with the academic demands of content classes because language is the major medium of instruction and it is a resource which is in short supply for the ESL student. For many students the language they have learned in an ESL support class may not prepare them to meet the demands of the content class. In summary one of the four assumptions of the Vancouver School Board ESL project asserts that:

...it is inefficient and ill-advised to teach language as a thing in itself separate from the school curriculum or conversely to submerge students in the language demands of school without structured support: ESL students require planned help with their real needs in coping with the language demands in the school context.

Some researchers suggest that ESL students need to acquire, in Cummin's words, cognitive academic language proficiency (CALP) in order to cope with the demands of the school context.

THE APPROACH

How can ESL students cope with the demands of content? A second assumption of the VSB ESL project is that:
in order to help students bridge the gap between beginning social acquisition and full social and academic linguistic competency in the mainstream classroom carefully articulated program which integrates the teaching of language and the teaching of subject areas needs to be developed.

Mohan's approach is a systematic way of integrating content objectives and language objectives. A third underlying assumption held by the VSB project is that integration can benefit the students, "it is important to find ways to continue all students' academic and cognitive development while they are in the process of acquiring English as a second language."

Mohan's knowledge framework was used to plan a unit of science work which integrated subject matter, a computer database and academic discourse in order to investigate the connections between these three areas.

METHOD

A qualitative approach was used to examine the connections among language, computers and content within the context of a science unit taught by a content teacher and a language specialist. Ethnographic observations, interviews, and recordings of the students and teachers as they work through the unit are reported in the form of a narrative in Chapter 3 to capture the context of the unit which is essential to illuminating the relationships among the three variables.

CONCLUSION

If there are organizational patterns in the biology content, the classification discourse, and the computer database which are the same, then this way of integrating these three areas in
student tasks may have the potential for promoting content learning and developing academic discourse.

Chapter 2 will examine some of the literature relevant to this question and will provide further background on the methodology used in this study.
Chapter 2
REVIEW OF SELECTED LITERATURE

A selected review of literature bearing on integrating content learning, academic language development and computer use is presented here. As a consequence of the integrative nature of the study, work has been drawn from a variety of sources.

There are four general areas which are considered to be particularly relevant to the problem: 1) the status of academic discourse in the field of second language acquisition, 2) the integration of language and content teaching, 3) the status of computer assisted language learning, and 4) general educational computer use in relation to thinking skills. As well as examining relevant substantive research the question of an appropriate research methodology will be addressed in this chapter.

1. SLA AND ACADEMIC DISCOURSE

The field of SLA has increasingly recognized that it takes considerably longer for ESL students in a school setting to acquire their second language than was ever thought necessary before. Researchers in Canada (Cummins) the U.K. (Ellis) and the U.S. (Wong-Fillmore, Saville-Troike, and Collier) are all in agreement that it can take anywhere from 4-8 years for ESL students to reach a level of proficiency in English comparable to their native speaking peers.

Cummins' (1982) theoretical model for SLA serves as a useful starting point for delineating two types of language proficiency: basic interpersonal communicative skills (BICS) and cognitive
academic language proficiency (CALP). While the use of these acronyms has been questioned by some researchers as over simplifying very complex concepts (see Cummins & Swain, 1983; Edelsky et al., 1983; Rivera, 1984) as Collier points out:

... the terms have become symbolic and meaningful for many people ... as a way of distinguishing between face-to-face conversational proficiency (BICS) and context-reduced, cognitively demanding aspects of language proficiency (CALP).

In BICS meaning can be negotiated and enhanced through a variety of paralinguistic and situational cues whereas CALP is primarily reliant on linguistic cues for meaning. According to Collier:

... it is especially in school that students need to develop context reduced and cognitively demanding aspects of language (CALP) in order to function successfully in the classroom.

While it is clear that it takes a very long time for ESL students to acquire CALP it is not so clear how to help the students develop cognitive academic language proficiency, although there is a growing understanding of the necessity of coming to terms with this complex issue.

2. INTEGRATION OF LANGUAGE AND CONTENT CLASSES

For the past few years the language teaching profession has focussed largely on the communicative aspects of language teaching and little has been done to integrate the work of language classes and content classes in the areas of first and second language development. In second language development there have been at least two comprehensive approaches developed which attempt to deal with the complex issue of developing CALP (Chamot & O'Malley, 1986; Mohan, 1986). Both Chamot's and Mohan's work
share similar assumptions about the problem but their solutions vary greatly. Both agree that language learning and content learning ought to be integrated. Chamot and O'Malley have developed the Cognitive Academic Language Learning Approach (CALLA) which in their words is a program, a curriculum, and an instructional approach. Chamot and O'Malley state that:

... the CALLA instructional approach is a cognitive one that develops students' ability to use effective learning strategies for both language and content-area tasks.

A significant difference between these two approaches is that Chamot and O'Malley use learning strategies to integrate language and content whereas Mohan uses knowledge structures. Both of these approaches, nonetheless recommend integrating language and content teaching as a means of addressing the complex issue of CALP.

There are some similarities between the fields of first and second language development with respect to the integration of language and content. As a means for examining this issue I reviewed the B.C. Ministry of Education curriculum guides which outline the goals and learning outcomes to be aimed for in B.C. schools. Two main themes became apparent. Firstly, in both elementary and secondary content areas such as science, mathematics, and social studies the content of these courses is first and foremost in importance in both the goals and learning outcomes listed in the guides. Language, when it is mentioned, is distilled to learning the technical vocabulary of the content area, no other aspects of language development connected with the content are noted.
Although reading in the content areas (RICA) strategies are widely recognized in their usefulness for helping students understand content their actual use in the schools may not be widespread. In a survey conducted by Gunderson, a representative sample of B.C. K-12 and adult teachers were asked if they used content area reading skills with their ESL students. 55 percent of the teachers were not involved in any form of reading instruction. A second question asked, "How could ESL students be better prepared to meet the requirements of your content classes?" 80 percent of the respondents reported that English proficiency should be a requirement of enrollment in content classes.

Gunderson concludes that:

... as a group ESL students are in jeopardy. First, content teachers do not restructure instruction in response to their needs and second, content area reading methods are not incorporated into secondary classrooms. ESL students are left to struggle with both the rigors of academic material and the difficulty of learning to comprehend text in English. It would seem that in many cases they fail at both tasks.

A second theme evident in both elementary and secondary curriculum guides was that language courses themselves appear dis-integrated. This is particularly so at the elementary level where language instruction is divided into three main areas; language arts, reading, and spelling. The syllabus for these areas bear no resemblance for each other. Each has a separate set of goals and learning outcomes. Additionally in the curriculum guides the language dealt with in the spelling, reading and language arts classes is not related to the language demands of the content area courses in any way. This is not to say that
some teachers are not attempting to integrate language and content instruction at the level of classroom work.

At the secondary level, English curriculum guidelines suggest that English is taught as a separate content area. No connections seem to be made between English and the other content areas, nor are strategies for reading and writing in the content areas dealt with in the curriculum guides for English courses.

3. STATUS QUO OF C.A.L.L.

Computer-assisted language learning (CALL) has largely reflected the trends in communicative language teaching and learning. Ahmad and Corbett in their book "Computers, Language Learning and Language Teaching" list types of activities they consider computers are appropriate for in the language classroom. Among these are exercises in inflectional morphology, derivational morphology, cloze, grammatical manipulations, and vocabulary. Leonard describes several computer applications similar to the above but also mentions activities which promote communicative language development. The same typology of activities at the computer also occurs in Hainline's "New Developments in C.A.L.L."

For the most part these authors look at the major goal of computers in language learning and teaching as fostering communicative language use not as a tool for developing content based language learning or for developing academic discourse.

How general educational computing has dealt with language issues appears to parallel the "isolated" treatment that language has received in the curriculum guides.
4. GENERAL EDUCATIONAL COMPUTER USE AND THINKING SKILLS

Educational computer use talks about the use of the computers for "thinking skills" but there is little work which shows how this might be integrated with the regular curriculum. "Developing Minds," a collection of articles on teaching thinking skills, catalogs computer software designed to teach specific thinking skills. The content of the software appears to be of secondary importance in comparison to the thinking skills themselves. The software is classified by thinking skill and few connections are made with particular content areas. In a more recent publication on thinking skill entitled "Tactics for Thinking," Marzano and Arredondo assert that:

. . . the skills described in Tactics are meant to be taught and reinforced within the regular content-area classroom as a way of teaching content. A basic assumption of this program is that you cannot separate the teaching of thinking from the teaching of content. You must practice thinking about something; classroom content is that "something." Similarly, learning content involves the use of complex thinking skills. Thinking and content are inexorably (sic) linked. As a result, the teaching of thinking as described in Tactics has the effect of improving a student's knowledge of content.

While the understanding of the importance of linking thinking and content is emerging, little software exists which integrates these areas.

In summary, the field of Second Language Acquisition has only recently begun to acknowledge the importance of developing academic discourse. It has largely been concerned with teaching language as a thing in itself apart from content. The field of computer assisted language learning (C.A.L.L.) has not ventured into the development of academic discourse nor has it considered
the computer as a means for integrating language and content teaching. General educational computing has made some attempts to generate software that teach students about thinking skills but the thinking skills they learn are in many cases divorced from the content they face in their classes. This summary of selected works, to the best of my knowledge, makes it clear that no attempts have yet been made to relate the integration of the teaching of content, the development of academic discourse, and the use of a computer database to the knowledge structure of classification.

METHOD

I would like to examine whether connections exist generally amongst the areas of curriculum content, computer use and academic discourse through an investigation of a specific unit of instruction which was designed to integrate biology material, the use of a computer database program and classification discourse.

1. The Knowledge Framework

In order to examine these connections I have used as a starting point Mohan's ideas on knowledge structures (Mohan, 1986). They provide an articulated basis for integrating language and content. I then chose computer software which might be integrated with this approach. The elaboration of Mohan's approach will include my rationale for why I chose a database for this study. Mohan argues that:
... in order to integrate language and content in the classroom you need ways to organize materials to aid both the development of language and the acquisition of content. You also need ways of coordinating language objectives with content area objectives.

Mohan outlines a systematic approach for relating language and content that applies across the curriculum. The approach also accounts for developing academic discourse and thinking skills related to content. He refers to this systematic approach as the knowledge framework. Mohan asserts that "topics" or content can be broken down into the six major types of knowledge which make up the knowledge framework: classification-concepts, description, principles, sequence, evaluation and choice.

According to Mohan each of these types of knowledge have unique or distinct linguistic features which structurally set them apart from each other. In addition Mohan says that each of these distinct knowledge structures can be represented graphically by "key visuals." These visuals have no or lowered linguistic demands and can help the learner understand content. This applies to both ESL and native-speaking learners. Key visuals have at least three major applications: 1) generative - to promote language generation (related to content), 2) representative or explanatory - to increase content understanding, and 3) evaluative - to evaluate content and language understanding.

In summary, the framework acts as an integrator of content and language. After a topic has been broken down into the six boxes of the framework, it provides a starting point for developing student tasks which integrate the development of academic discourse and the comprehension of content. Key visuals can be
used in tasks as links between language and content for the learner.

In this study I have concerned myself with biology content and the academic discourse of classification and description as they relate to the knowledge structures of classification and description (see Figure 2.0).

The visuals that are typically used to represent this knowledge structure are classification trees and certain types of charts.

The multiple record format of the Appleworks database program resembles the charts (key visuals) most often used for classification. In some ways then a computer database program can be likened to a key visual. My question is, can a computer database be used as both a means for presenting classificatory knowledge and the means for generating classificatory language?

Figure 2.0 - Connections

```
classification (database program) discourse

<table>
<thead>
<tr>
<th>classification principles evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>description sequence choice</td>
</tr>
</tbody>
</table>
```

The Knowledge Framework (Mohan 86)
2. **Qualitative Approach**

A qualitative approach was adopted to examine the integration of language, content, and computers as they relate to the knowledge structure of classification and description. Qualitative methods were chosen because they are particularly well adapted to showing contextual connections. They also allow you to focus on relationships between various elements and to see how the elements form something of an integrated whole which I think is necessary for the examining unit of work.

The following types of data were collected and drawn on to write a detailed narrative of the unit which is in Chapter 3.

1. **a. documents on teacher planning**

2. **recordings and transcriptions of student interactions at the computer**
   a. 12 student pairs choosing examples from vertebrate classes x 7-9 minutes of talk
   b. 12 pairs of students developed 3-5 definitions each pair taking 15-30 minutes
   c. two groups of students half of class in each group - follow up to pair work above
   d. 12 student pairs classifying vertebrates at the computer - approx. 8 minutes each

3. **field notes on classroom observation**

4. **recorded interviews of teachers and students**
   a. 3 hours of interviews with teachers
   b. 3 hours of interviews with 6 students

5. **oral and written tests**
   a. 6 oral tests x approx. 30 minutes
   b. 25 written tests x 3 pages

The Narrative in Chapter 3 sets the context for examining and analyzing the connections among content, computers and discourse in Chapter 4. As an aid to identifying the types of
discourse the students engaged in as they worked through the unit
I have drawn on Smith and Meux's largely overlooked work in the
area of concept ventures. Their scheme for analyzing discourse
has more recently been used in Maminta's 1985 paper on Forms and
Functions in a "Concept Venture" in Science and Mathematics.
Concept ventures relate to Mohan's knowledge structure of
classification (classes or concepts).

I will identify and comment on the various types of concept
ventures found in selected portions of student discourse using
the following definition as a guideline.

**SMITH AND MEUXS' CONCEPT VENTURES**

The overarching objective of this type of venture is a set
of conditions either governing, or implied by, the use of a term.
These conditions constitute criteria for determining whether
something is or is not a member of the class of things referred
to by the term. A concept involves a class of things and the
criteria by which members of the class are identified. Typi­
cally, a conceptual venture contains a concept's name and other
aspects such as criteria and instances.

The primary cognitive import of this type of venture is that
of disclosing the conditions or criteria governing the use of a
term. A term may be a single word such as "imperialism," or an
expression of two or more words such as "coefficient of expan­
sion." A conceptual venture may be identified by one or more of
the following criteria:

1. An X is mentioned and the class discussion is primarily
to such questions as What is X? What does X mean? What do we
mean by X? How can we tell when something is an X?

2. Something is named or referred to, and the class discussion is mainly devoted to describing its characteristics, functions, uses, or parts.

3. Something is named or referred to, and the class discussion is primarily devoted to mentioning or considering examples of it.

Smith and Meux identify 15 types of concept ventures; each of these are defined more fully in Appendix A.
Chapter 3
THE NARRATIVE

A. BACKGROUND TO THE UNIT

This unit was designed in accordance with the general objectives of the B.C. Ministry of Education and the Vancouver School Board for grade 7 Science. The underlying goal of the curriculum was Biology content: the classification of living things. A grade 7 Science teacher and a language specialist taught the unit to grade 7 students at Beaconsfield Elementary School over the 1987-1988 school year. The unit has two major parts. Part I of the unit, follows the chapter on "The Classification of Living Things" in the Ministry of Education prescribed text Exploring Living Things. The students spent much of their time working out definitions of animals, plants and protists. Part II of the unit represents the focus of this study and was developed according to Mohan's language and content principles, as described in Chapter 2, to orchestrate the integration of biology content, language development and computer use. Computers were used to support the goal of the students acquiring content information and to act as an arena or catalyst for language development.

Overview of Lessons 1-7

Part II of the unit reflects a planned integration of content learning - the classification of vertebrates, academic language development and computer use based on Mohan's knowledge framework. As part of the preparation for the unit, a database on the five classes of the vertebrates was developed using the Appleworks Program (an integrated word processor, database and
spreadsheet). All of the lessons are in some way tied to the use of the database.

The tasks in Part II of the unit were designed around a computer database on vertebrates to help the students develop their concepts of what vertebrates (mammals, birds, amphibians, reptiles and fish) are. They used the definitions they had developed to classify other vertebrates in the database which were not identified by name or class. Following, this the way information on individual records was stored in the database served as template for researching other vertebrates to add to the database. Lastly, the students sorted, arranged, and classified information about vertebrates in the database.

The first lesson is a brief review of Part I of the unit plan. It sets the stage for a more in-depth examination of the classification of living things, in particular the classification of vertebrates.

Lesson 2 asks the student to suggest characteristics vertebrates have in common, e.g., skin covering, locomotion, diet, and so on. These same descriptors were used to show the differences among vertebrates as well. The students then ordered the descriptors from most significant to least in their ability to show differences among the vertebrates. For example, body temperature was significant because it separated the vertebrates into two large groups: those that are warm blooded and those that are cold blooded.

In lesson 3 the students worked in pairs at the database of vertebrates getting examples of each of the vertebrates to fill
into a chart.

The chart was then used in lesson 4 as the graphic from which the students (the same pairs above) developed definitions of mammals, birds, amphibians, reptiles and fish.

After each of the pairs of students had written their five definitions, the class as a whole was asked to agree on each of the definitions. Because each pair had based their definitions on different animal examples from the database the definitions in some cases were different from each other. The students offered information which lead to the modification of the group definition.

The students examined a modified section of the database in lesson 5 which did not identify the name or class of selected vertebrates. Using their definitions, the students classified the vertebrates as mammals, birds, amphibians, reptiles or fish.

In lesson 6 the students researched other vertebrates using the descriptors used in the database as a starting point for collecting information. Once collected the students entered the information on the database.

In lesson 7 the students learned how to manipulate the database to do other classificatory activities. For example they could cross-classify the vertebrates in the database by diet and end up with three groups: carnivorous, herbivorous and omnivorous (see Appendix B for the lesson plans).

THE DATABASE

The central focus of the second part of this unit is the
classification of vertebrates. An integral part of this planning was the development of a database on vertebrates using Appleworks (an integrated word processor, database and spreadsheet program). The Appleworks database program has two key components: The first is the management program which allows the user to manipulate the second component of the program which is the database, which is in this case is information about vertebrates.

The database template was designed to correspond in its structure to an adaption of the classification tree on page 93 of Exploring Living Things (see Figure 3.0). The database reflects the vertebrate section of the visual.

Figure 3.0 - The classification of living things

```
[Diagram showing the classification of living things]
```

The database includes 15 animals from each of the five classes: mammal, bird, amphibian, reptile and fish. A wide variety of animals from each of the classes were researched and included in the database. See Appendix C for a listing of the 75 vertebrates. Records in the database can be displayed in two formats: the multiple record format or the single record format. The single record format is a description of each vertebrate and as designed for this study includes the information shown in
Figure 3.1.

**Figure 3.1 - Single record format template**

<table>
<thead>
<tr>
<th>Name</th>
<th>common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>mammal, bird, amphibian, reptile or fish</td>
</tr>
<tr>
<td>Body temperature</td>
<td>warm blooded or cold blooded</td>
</tr>
<tr>
<td>Respiratory system</td>
<td>lungs or gills</td>
</tr>
<tr>
<td>Skin covering</td>
<td>smooth, hair, fur, or scaly</td>
</tr>
<tr>
<td>Reproduction</td>
<td>born alive or eggs</td>
</tr>
<tr>
<td>Appendages</td>
<td>limbs, legs, wings, fins, none</td>
</tr>
<tr>
<td>Habitat</td>
<td>land or water</td>
</tr>
<tr>
<td>Hibernation</td>
<td>yes or no</td>
</tr>
<tr>
<td>Locomotion</td>
<td>walk, swim, fly, slither</td>
</tr>
<tr>
<td>Migration</td>
<td>yes, no, partial</td>
</tr>
<tr>
<td>Diet</td>
<td>carnivorous, herbivorous or omnivorous</td>
</tr>
</tbody>
</table>

B. THE NARRATIVE

The general outline for what follows is a description of the lessons as they were planned, a summary of what actually happened in the classroom (how tasks and activities built on one another) and commentary on the integration of biology content, use of a computer database and academic discourse. As outlined in Chapter 2, the narrative is based on ethnographic observations, interviews and recordings of the students and the teachers as they worked through the unit. The narrative provides a context for which to examine the connections among the three variables. These connections will be analyzed more fully in Chapter 4.

The major emphasis both in time spent in the unit and for analysis in this study is in lesson 4 where the students wrote definitions for each of the vertebrate classes: mammals, birds, amphibians, reptiles and fish. It is in this lesson that the connections between the subject matter, the database and the academic discourse can be seen most vividly. Lesson 4 is central
Lessons 1-3 set the context for the unit. They focus on how vertebrates are classified and provide through the computer database and through some guidelines for definition writing the raw materials from which to write definitions in lesson 4. Lessons 5, 6, and 7 provide the students with opportunities to use their definitions to do other tasks related to the classification of vertebrates. The amount of time spent on these lessons in total was far less than the time spent on lesson 4.

LESSON 1

The aim of lesson 1 is to review for the students the groups by which living things are classified and in particular to introduce the students to the classification of vertebrates.

Up to this point the students had studied the differences and similarities of animals, plants and protists. The students were exposed to an increasingly detailed examination of living things. The students had studied protists in some detail, in Part I of the unit, but they had not, at this point, studied the classification of plants or animals to any degree. We decided to examine the animal kingdom. As a way of initiating the topic the students were presented with an unlabelled key visual; a classification tree, showing what groups living things are divided into (as adapted from page 93 of Exploring Living Things, see Figure 3.2). The students filled out the names of the three groups of living things: plants, animals and protists.
The teachers then had the students brainstorm names of animals. As names were called out the teachers put the animals into one of two groups, the titles of which were concealed from the students. When a suitable number of animals were listed, the students were asked how the two groups were different. Eventually, with the teacher's guidance, the students were able to conclude that one group had backbones but the other one did not. The teachers supplied the students with the correct biological terms: vertebrates and invertebrates and placed them above the appropriate group. Following this the students added more animals to each group. Of the two groups the vertebrates were investigated in more detail. The students generated the names of the classes of the vertebrates they knew and the teachers filled in the rest. They then added a few examples of each class.

**Figure 3.2** - Key visual for classification of living things

```
  living things
    /\                  /\                  /\
   /  \                /  \                /  \                  /\
  animals  vertebrate invertebrate
    /\                  /\                  /\
  mammals  birds  reptiles  amphibians  fish
  dog  robin  snake  frog  salmon
  human  lizard  salamander
```

**LESSON 2**
The aim in lesson 2 was for the students to examine features or characteristics that each of the classes have in common and to determine which of these features are most significant in their ability to show the differences among the classes and for students to familiarize themselves with the format of how descriptions of vertebrates are organized in a database.

The first step in this direction, asks the student to suggest characteristics vertebrates have in common, e.g., skin covering, locomotion, diet and so on. These same characteristics had been used in creating a database on the vertebrates, however the characteristics are referred to here as descriptors. This was the first of two lessons which focussed on the makeup of a definition. Because the database had to be prepared in advance the teachers could not create it based on the descriptors the students had generated. As it turned out the students did come up with many of the descriptors in the exercise below. The students were given a partially filled in chart (see Figure 3.3) with the descriptors on the left and examples of how these descriptors would be manifested amongst the vertebrates on the right. In some cases the examples were limited definitions of the descriptors, e.g., descriptor: habitat, example: land or water. In others the examples described the occurrence of some phenomena, e.g., descriptor: migration, example: yes, no, or partial. While the descriptors served to show the similarities amongst vertebrates, the examples of the same descriptors were being used to show the differences amongst them.
The students then ordered the descriptors from most significant to least according to their ability to show differences amongst the vertebrates. For example body temperature was considered significant because it separated the vertebrates into two large groups: those that are warm blooded and those that are cold blooded. Again this component of a definition was focussed on in order to give the students input when it came time for them to write definitions of the vertebrate classes in subsequent lessons. The model for the definition was not made explicit to the students at this time, had it been it would have resembled this:

A ______ is a vertebrate which ______
(class) (unique features)

Figure 3.3 - Student exercises on descriptors

A. Instructions - Read this exercise carefully and with your partner and supply the missing information. You may have to use a dictionary.

<table>
<thead>
<tr>
<th>DESCRIPTORS</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ___________</td>
<td>cold/warm blooded</td>
</tr>
<tr>
<td>2. respiratory system</td>
<td>__________, __________</td>
</tr>
<tr>
<td>3. skin covering</td>
<td>__________, __________,</td>
</tr>
<tr>
<td></td>
<td>__________</td>
</tr>
<tr>
<td>4. ___________</td>
<td>born alive, eggs</td>
</tr>
<tr>
<td>5. appendages</td>
<td>legs, __________, __________</td>
</tr>
<tr>
<td>6. habitat</td>
<td>__________, __________</td>
</tr>
<tr>
<td>7. hibernation</td>
<td>__________, __________</td>
</tr>
<tr>
<td></td>
<td>__________</td>
</tr>
<tr>
<td>8. locomotion</td>
<td>__________, __________</td>
</tr>
<tr>
<td>9. migration</td>
<td>__________, __________</td>
</tr>
<tr>
<td></td>
<td>__________</td>
</tr>
<tr>
<td>10. diet</td>
<td>__________, __________</td>
</tr>
</tbody>
</table>
B. Order the descriptors from the most significant to the least significant in showing the differences among the five classes of vertebrates.

1.  6.  
2.  7.  
3.  8.  
4.  9.  
5.  10.  

Part A above took the students longer to do than expected. The vocabulary for many of the students was new and it was difficult for some to do the task.

In Part B half of the students had a difficult time understanding the assignment, especially the ESL students. More time was given to the students to do the task. The students seemed to have a difficult time because they were still grappling with the meaning of the descriptors. This would obviously have some bearing on their ability to order the words.

LESSON 3

The aim for lesson 3 was to introduce the students to the organization of a database. In this case how the single record and multiple record formats display information in order for them to select examples of each class of the vertebrates to be used to generate a definition in lesson 4.

Although the students had not worked with the vertebrate database prior to this lesson, they were prepared in two ways to deal with it. Firstly, they had used the Appleworks Database Management program with a different database and were thus familiar with the principles of database operation. Secondly, the students were familiar with the single record format of the
records in the vertebrate database having worked through the exercise on descriptors in lesson 2 which duplicates the single record format.

All of the activities that follow were done in pairs and in some cases small groups to maximize opportunities for the discussion of biology content.

The first activity the students did with the database was to select an animal from each class; mammal, bird, amphibian, reptile and fish and fill in their descriptors in a chart. This entailed scrolling through each of the 15 animals in each class, while in the multiple record format (in which the animal names are listed on the vertical axis and the descriptors are listed on the horizontal axis at the top of the screen, see Figure 3.4), choosing an animal and then switching to the single record format (Figure 3.1) to read the information on a particular animal and then fill in the chart. The chart was designed to resemble the multiple record format of the database which was based on the classification of living things key visual (Figure 3.2).

The following is a sample of what the students were saying and doing at the computer while they were selecting examples of each of the vertebrates to fill in their charts. 12 pairs of students each selected one vertebrate from each class.

**Example 1**

Kathy (ESL) and Kevin (NS) selected an amphibian from the database for their chart:

Kevin: now we have to choose an amphibian ... which one do you want?
**Figure 3.4** - Multiple record format vertebrate database

<table>
<thead>
<tr>
<th>NAME</th>
<th>CLASS</th>
<th>BODY TEMP</th>
<th>RESP SYST</th>
<th>COVERING</th>
<th>APPENDAGE</th>
<th>HABITAT</th>
<th>HIBRITM</th>
<th>MIGRATION</th>
<th>DIET</th>
</tr>
</thead>
<tbody>
<tr>
<td>cheetah</td>
<td>mammal</td>
<td>warm blood</td>
<td>lungs fur</td>
<td>born limbs</td>
<td>land</td>
<td>no walk</td>
<td>no swim</td>
<td>no</td>
<td>carniform</td>
</tr>
<tr>
<td>duck-billed</td>
<td>mammal</td>
<td>warm blood</td>
<td>lungs fur</td>
<td>eggs legs</td>
<td>water</td>
<td>no swim</td>
<td>no</td>
<td></td>
<td>carnivorous</td>
</tr>
<tr>
<td>platypus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>horse-shoe bat</td>
<td>mammal</td>
<td>warm blood</td>
<td>lungs fur</td>
<td>born wings</td>
<td>land</td>
<td>yes fly</td>
<td>no</td>
<td>carniform</td>
<td></td>
</tr>
<tr>
<td>flamingo</td>
<td>bird</td>
<td>warm blood</td>
<td>lungs feather</td>
<td>eggs wings</td>
<td>land no walk</td>
<td>yes</td>
<td></td>
<td></td>
<td>omnivorous</td>
</tr>
<tr>
<td>king penguin</td>
<td>bird</td>
<td>warm blood</td>
<td>lungs smooth</td>
<td>eggs wings</td>
<td>water no swim</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>swan</td>
<td>bird</td>
<td>warm blood</td>
<td>lungs feather</td>
<td>eggs wings</td>
<td>land no fly</td>
<td>yes</td>
<td>omnivorous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>adder</td>
<td>reptile</td>
<td>cold blood</td>
<td>lungs scales</td>
<td>eggs none</td>
<td>land yes slide</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td>theropodiform</td>
</tr>
<tr>
<td>alligator</td>
<td>reptile</td>
<td>cold blood</td>
<td>lungs scales</td>
<td>eggs legs</td>
<td>water no swim</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>boa constrictor</td>
<td>reptile</td>
<td>cold blood</td>
<td>lungs scales</td>
<td>born none</td>
<td>land yes slide</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td>theropodiform</td>
</tr>
<tr>
<td>brown spelepes</td>
<td>amphibian</td>
<td>cold blood</td>
<td>lungs smooth</td>
<td>born legs</td>
<td>land yes walk</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td>theropodiform</td>
</tr>
<tr>
<td>caecilian</td>
<td>amphibian</td>
<td>cold blood</td>
<td>lungs smooth</td>
<td>eggs none</td>
<td>land yes slide</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td>theropodiform</td>
</tr>
<tr>
<td>fire-belly</td>
<td>amphibian</td>
<td>cold blood</td>
<td>lungs scales</td>
<td>eggs legs</td>
<td>land yes swim</td>
<td>no</td>
<td>carniform</td>
<td></td>
<td>theropodiform</td>
</tr>
<tr>
<td>Atlantic salmon</td>
<td>fish</td>
<td>cold gills scales</td>
<td>eggs none</td>
<td>water no swim yes</td>
<td>carniform</td>
<td>theropodiform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bluefin tuna</td>
<td>fish</td>
<td>cold gills smooth</td>
<td>eggs none</td>
<td>water no swim no</td>
<td>carniform</td>
<td>theropodiform</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sea-perch</td>
<td>fish</td>
<td>cold gills scales</td>
<td>born none</td>
<td>water no swim no</td>
<td>carniform</td>
<td>theropodiform</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Kathy scans through the database while it is in the multiple record format - moves the cursor to Firebelly - presses keys (open apple - Z) to zoom in on the Firebelly record (single record format).

Kathy reads while Ricardo jots down the information on the chart.

Kathy: Firebelly
Kevin: OK
Kathy: cold blooded
Kevin: OK
Kathy: lungs
Kevin: OK
and so on

Example 2

Ricardo and Chris (both ESL) chose to retrieve information on the Kingfisher from the records on birds.

R: Kingfisher? OK
C: body temperature? OK body temperature
R: it's warm blooded
C: OK
R: OK respiratory system
C: lungs
R: and the covering is feathers
C: the reproduction is eggs
R: appendages is a wings right?
C: yup
R: its wings, that's it? OK
C: habitat is land
R: uu huh (yes)
C: hibernation .. no .. just put no
R: locomotion .. it flies
C: fly
R: hiber/migration .. no
C: carnivorous

Figure 3.5 is an example of a completed classification chart.
LESSON 4

Aim: For the students to generalize from their specific examples of each class and write definitions of each class.

Before the students began writing their definitions they worked through a series of short tasks on what made a good definition. Initially the students were presented with a definition of a definition. They were then shown definitions which were very vague. For example: a mammal is a vertebrate which has appendages. The students were asked what was wrong with the definitions. The underlying aim was to show the students how important it was to include features that were unique to a particular class in a definition.

The students were asked to make their definitions precise and and capable of sorting animals into the appropriate vertebrate classes. This meant selecting the examples of the descriptors which were unique to a class and using this information to write definitions for each of the five classes, e.g.,
"A mammal is a warm blooded vertebrate which bears its young alive and ..." This involved the students in comparing and contrasting the characteristics of each class from their charts, then listing the descriptors that were unique to each class and finally using this information to write their definition.

Once the definitions were completed the plan was to have the students begin classifying animals in the database using their definitions to help them, however the two periods that had been planned for the students to write the definitions in proved to be too little time. It was evident to both teachers from a quick review of the students' first drafts that the definitions needed more development. This was not seen as being a negative experience but one that would provide positive opportunities for language development.

The language teacher suggested that the pairs of students be combined to form two groups. Each group was then responsible to write a "group" definition for each of the vertebrate classes. The process followed in the task was identical to how the students had done their first drafts of the definitions. The students' goal was to include features in the definitions that demonstrated the uniqueness of each class. Each teacher acted as facilitator to help the groups along. Students took turns offering features they thought should be in the definition of the mammal. This discussion provided a venue for students to share the background knowledge they had on vertebrates on their charts. The sharing of this knowledge necessitated making changes in definition. The following dialogue occurred in one group:
Tara: I think it should be mammals are born alive
Jenny: But there's this animal the duck-billed platypus it's a mammal and it has eggs (one of the animals in the database).

The teacher asked how Tara's phrase might be changed to account for this fact. Students suggested using words like "almost all" or "most." The teacher pointed out that adding words like these (qualifiers) made the definition more accurate. Ten days later the students were still working on their definitions not only in science but in any spare time that could be found. The language specialist felt that the unit had really taken flight at this time. The content teacher was amazed at the students' sustained interest in discussing and writing accurate definitions. Even when the students had to go on to the next lesson in the unit, that of classifying animals on the database, the content teacher, now two weeks later, was still working on the language and content accuracy of the students' definitions.

Other language development issues arose and while not all difficulties were addressed by the teachers, the difficulties the majority of the students had were. For example, the language specialist identified certain morphological errors in several of the definitions, e.g., many students used the descriptor locomotion in this way "its locomotion is walking" instead of "its form of locomotion is walking." While the students were familiar with the words it appeared as though they were unsure as to how to fit them in the definitions. (The students had done some work with the words prior to writing the definitions but
this was done in a different context.)

Lessons 5, 6, and 7 gave the students an opportunity to use their definitions to classify other vertebrates, to research vertebrates from each class and lastly to explore other ways to classify vertebrates using the database.

LESSON 5

The aim in lesson 5 was for the students to use their definitions of the vertebrate classes to classify other vertebrates.

The students now had working definitions of each of the five classes. Their next task was to examine a modified section of the database (which included only the characteristics of the vertebrates but did not include the name or class of the vertebrates, a format very similar to that in Figure 3.4) and classify the vertebrates into the five classes. They used their definitions to assist them in this task. The students did this work in pairs and had to agree on what class the animal belonged to and why they thought so. The lesson took one period to complete.

LESSON 6

The aim in lesson 6 was for the students to use their knowledge of vertebrates to research other vertebrates and to add those records to the database.

The students researched other vertebrates using the database single record format as a guideline for retrieving information from reference materials (see single record format in Fig. 3.1).
Each pair of students was given a form with the descriptors laid out as they occur on the database, e.g., Name:, Class:, Body Temp.:, etc.

As an example of the students drawing on their background knowledge of vertebrates to do this task one of the students commented, "Some of the descriptors could be filled out automatically because you knew that class had certain things true all the time, like mammals are always warm blooded." This lesson was accomplished in one period.

**LESSON 7**

The aim in lesson 7 was for the students to classify information in the database and test their definitions. The students learned to use logical operators to make statements to further classify information in the database, for example class = mammal would select all the records on mammals, diet = carnivorous would select all the vertebrates from the database that were carnivorous.

In this lesson the students were shown that they could classify all of the vertebrates in the database by their characteristics. The rules for retrieving information from the database were demonstrated. For example, in order to determine which vertebrates are carnivorous one would input the selection rule, "diet = carnivorous." The data management program would search each of the vertebrate files and display those which had a carnivorous diet.

Further to this classes can be classified by their characteristics or descriptors as well. For example the
selection rule "class = mammal and migrate = yes," would answer the question, "Which mammals migrate."

The students were presented with questions and were asked to write the selection rules which would retrieve the information from the database to answer the questions.

Finally, in groups the students composed five questions to ask of the database. These questions were given to different groups who in turn composed selection rules to answer the questions. Once the rules were written the students used the database to check if their rules answered the questions.

By the time lesson 7 was completed the students had spent three months on this unit. The teachers felt that the students had benefited from this content-based language learning unit. The science teacher felt that having the computer database central to this unit helped to sustain the students interest throughout a very extended time.
Chapter 4
ANALYSIS

Mohan's knowledge framework has provided a starting point for planning this unit and also a frame of reference for analyzing it. While the preceding chapter focussed on giving a context for this discussion, the purpose of this chapter is to examine the connections between biology subject matter, a computer database, classificatory discourse and the knowledge structures of classification and description within the unit.

Figure 2.0 graphically represents the links between these three areas:

![Figure 2.0 - Connections](image)

UNIT PLANNING

Before considering a lesson by lesson analysis of the connections mentioned above, the background and planning behind this unit will be reported.

The major objective behind this work was for the students to understand how vertebrates are grouped into five classes; mammals, birds, amphibians, reptiles and fish. To understand
this classification scheme, it was necessary for the students to build their concepts of each class. Lessons 1-4 were planned to meet this objective where the students wrote their own definitions of each class. In lessons 5-7 the students used the definitions they had developed to perform other tasks related to the classification of vertebrates.

To make the link between biology and definitions, a database of the vertebrate classes was designed and assembled before the unit was executed. The database was designed in order to provide information about vertebrates and to provide a structure which might be used to write a definition of each vertebrate class. The database’s organization is reflective of the classification tree of living things as shown on page 93 in the grade 7 science text, however the database includes examples of vertebrates whereas the tree does not. In other words, the database reflects the organization of the chart but also extends the pool of information on vertebrates (see Figure 3.2).

**Figure 3.2** - Key visual for classification of living things

```
living things
     /       \
    /         \
animals     invertebrate
     /       \
   /         \
vertebrate  
```

- mammals  birds  reptiles  amphibians  fish
  - dog  robin  snake  frog  salmon
  - human  lizard  salamander
The second role of the database was to provide a structure for writing definitions of the vertebrates. The database was designed to reflect what characteristics vertebrates had in common. The following descriptors were used: name, class, body temperature, respiratory system, skin covering, reproduction, appendages, habitat, hibernation, locomotion and migration. These descriptors were then used as the building blocks for designing the single record format for the computer database on vertebrates. When researching information on vertebrates the following template in Figure 3.1 was used:

Figure 3.1 - Single record format template

Name: common name
Class: mammal, bird, amphibian, reptile or fish
Body temperature: warm blooded or cold blooded
Respiratory system: lungs or gills
Skin covering: smooth, hair, fur, or scaly
Reproduction: born alive or eggs
Appendages: limbs, legs, wings, fins, none
Habitat: land or water
Hibernation: yes or no
Locomotion: walk, swim, fly, slither
Migration: yes, no, partial
Diet: carnivorous, herbivorous or omnivorous

These descriptors are arranged in a single record format. The descriptors are arranged on the left side of the page and how the descriptors are manifested are on the right opposite as seen in this example of the Beluga Whale in Figure 4.0.

Figure 4.0 - Single record format - example

Name: Beluga Whale
Class: mammal
Body temperature: warm blooded
Respiratory system: lungs
Skin covering: smooth
Reproduction: born alive
Appendages: fins  
Habitat: water  
Hibernation: no  
Locomotion: swim  
Migration: yes  
Diet: carnivorous

There are 75 records of vertebrates (15 from each class - mammals, birds, amphibians, reptiles and fish) in the database. Each record is like an abbreviated description of a particular vertebrate. The management component of the Appleworks database program allows the user to display records on the computer, in a single record format as above or in a multiple record format.

The multiple record format displays several records at one time. The same descriptors are used but are positioned on the horizontal axis rather than on the vertical axis as is the case with the single record format (see Figure 3.4).

The organization of each of these formats is related to the knowledge structures of classification and description. Each single record format is similar to a description for a particular vertebrate. Records displayed in a multiple record format reflect a rudimentary classification of sorts.

The descriptors, the single record format, and the multiple record format provide the structures for how the biology information is organized and displayed and provide a reference point for the major goals of the unit.

I think it is quite clear that the organizational pattern of information on vertebrates and the organizational pattern of the database are connected. The database provides an empathetic structure for organizing the information on vertebrates.
This next section will examine how biology content, computer database and classificatory discourse are related to the knowledge structures of classification and discourse. Mohan has described six knowledge structures which represent the major ways that information is structured. The knowledge structures considered here are those of classification and description. How, then are the major components of this unit: content, computers and language, related to the knowledge structures of classification and description?

CONNECTIONS

For each of the lessons the following information will be discussed: an overview of the task and its purpose and the relationship between the content, computer database, language and the knowledge structures of classification and description. Smith and Meuxs' concept ventures are used to analyze the examples of student discourse in this chapter (see Chapter 2 and Appendix A for more background on concept ventures).

Lessons 1-4 as mentioned previously were designed to help the students develop definitions of the vertebrates. Each lesson provided a building block for this purpose.

LESSON 1
Purpose of the Task

Lesson 1 provides the context for the rest of the unit. The classification of living things chart on page 93 of the science text was discussed (see above). Prior to this lesson the students had not studied vertebrates in the class.
Content

The major focus for the content revealed how living things can be further classified into vertebrates and invertebrates and that vertebrates can be classified into five classes: mammals, birds, amphibians, reptiles and fish. The content is quite clearly tied into the knowledge structure of classification.

Language

To sum up the lesson, the students received an oral description of Figure 3.2. There are three major groups of living things: animals, plants and protists. The animal kingdom can be divided into two large groups, the vertebrates and the invertebrates. The vertebrates can be classified into five classes: mammals, birds, amphibians, reptiles and fish. The discourse in this lesson is largely classificatory and, as such, is connected to the knowledge structure of classification.

This lesson sets the context for the introduction of the descriptors in lesson 2 which in turn sets up a context for introducing the use of the computer database in lesson 3.

LESSON 2

Purpose of the Task

The purpose of lesson 2 was for the students to see what characteristics vertebrates have in common. This task also set the students up for writing definitions in later lessons. They also had to make judgements about which descriptors might be more powerful in separating the vertebrates into groups.
Content

The content in this unit has to do with a definition of a vertebrate. The descriptors were focussed on to set the stage for introducing vertebrate examples in lesson 3 which would be the basis for writing definition in lesson 4. According to Mohan definitions are related to the knowledge structure of classification.

Computer

The students were introduced to the descriptors on paper first. They occurred in the same order that the descriptors are arranged in, in the single record format of the computer database. Again as above this is related to the knowledge structure of classification.

Language

Each descriptor was considered a vocabulary item. The students had to know the words in order to later, in lesson 4, write definitions incorporating them. Part of learning the meanings of the words also entailed making judgements about which of them would be more useful in separating the vertebrates into classes. These activities were done to give the students some input as to how definitions are structured in order to prepare them for lesson 4. Definitions are related to the knowledge structure of classification.

LESSON 3

Purpose of the Task
The students used the computer database to retrieve examples of vertebrates to use to write definitions in lesson 4.

Content

The students assembled a classification chart of vertebrates which reflects the Living Things classification tree. The chart shows that the vertebrates are grouped into five groups and provides the vertebrate examples for the students to begin thinking about in order to write definitions for each class.

Computer

In this activity the students used the database management program to manipulate records of the vertebrates in order to fill in a chart. Both the single record and multiple record formats were used throughout this task. The single record format was used to retrieve information. As discussed earlier the single record format is related to the knowledge structure of description and the multiple record format is related to the knowledge structure of classification.

Language

The students read descriptions (records) of several animals and discussed which ones to include in their classification chart.

LESSON 4

Lesson 4 is the central part of this unit and a great deal of attention has been devoted to examining the academic discourse issues that arose during the lesson.
Purpose of the task

The main purpose of this lesson was for the students to think about, talk about and then write their definitions for the five vertebrate classes. This is the culmination of the last three lessons.

Content

Using the vertebrate examples, the students composed definitions for each class. The definitions are related to the knowledge structure of classification.

Computer

The students used a form generated from the records in the database. The form resembled the multiple record format which is related to the knowledge structures of classification and description.

Language

In this task the students wrote definitions of the vertebrates. The following discourse is the students' discussion of what characteristics (descriptors) should be included in the definition.

As previously described Smith and Meux's examples of concept ventures are used here to categorize the nature of the discourse.

Some Examples: Thai - ESL Student Dawn - Native Indian

classificatory T: A mammal is .. let's see .. umm a mammal is
description, an animal that is got reproduction and ..
characteristic characteristic D: has .. a mammal has reproduction .. they're
The following is a first draft of Thai and Dawns’ definition of a mammal: A mammal is an animal that is born alive and breathes with lungs and lives on land.

Thai and Dawn are writing definitions which are considered to be a component of the knowledge structure of classification. They are discussing the important features of the definition in order to write it. The discourse appears to reflect Thai and Dawns’ thoughts about mammals. Thai has identified being born alive as an important feature to have in the definition about mammals. According to Smith and Meux this qualifies as a sufficient condition because this one feature sets mammals apart from all of the other classes. This feature and the others in the transcription are relevant characteristics of mammals which are in turn relevant to a definition. According to Smith and Meux’s concept ventures Thai and Dawn appear to be involved in classificatory discourse. They have described a sufficient condition.
Examples: Scott and Jenny

The dialog concerning a definition of a bird below is based on the chart Jenny and Scott filled out above:

request for
sufficient condition
S: Kay, birds .. um, lay eggs .. um, what’s the most important thing here?
sufficient condition
J: I would say feathers
classificatory description, sufficient condition
S: cause they’re the only group that has feathers?
classification
S: so it’ll say .. a bird is an animal that is covered with feathers and is warm blooded with lungs
characteristic classification
J: yeah, also laying eggs is really important
characteristic, classification
S: yeah
characteristic, classification
J: well, what we could, what we could do .. a bird is a egg-laying animal with feathers and is warm blooded
characteristic
S: yeah
characteristic
J: cause like, a lot of them have lungs
characteristic, as above
S: yeah, but that’s not that important
characteristic
J: OK, so we said a bird is an egg-laying animal with feathers and is warm blooded. OK (writing definition) a bird is an
characteristic
S: egg-laying .. animal
characteristic, sufficient condition
S&J: with feathers and is warm blooded
characteristic

The following is a first draft of Scott and Jennys’ definition of a bird: A bird is an egg laying animal with feathers and is warm blooded.

The students were writing definitions which are considered to be a component of the knowledge structure of classification. They were discussing the important features of the definition in order to write it. The discourse appears to reflect Scott and
Jennys' thinking processes. Having scanned the chart Jenny has identified feathers as being an important feature to have in the definition about birds. There were no other vertebrates which has feathers for a body covering on the chart. This qualifies as a sufficient condition because this one feature sets birds apart from all of the other classes. This feature and the others in the transcription are relevant characteristics of birds which are in turn relevant to a definition as Smith and Meux's categories indicate.

All of the other pairs of students who did this task were involved in the same type of discussion using classificatory discourse as they created their definitions.

Following are the students' first attempts at writing their definitions of mammals:

David (NS) and Pat (ESL)

A mammal is a warm blooded animal it has lungs and fur and it also born alive and their diet is omnivorous.

Stuart (NS) and Lucy (ESL)

A mammal is an animal that is warm blooded. Most breathe through lungs.

Tony (ESL) and Tara (NS)

A mammal is a warm blooded vertebrate wich mostly lives on land The mamals respiratory system is lungs and its babies are born alive and also (most) mamals walk.

Wei Ping (ESL) and Gerard (ESL)

A mammal is a warm blooded animal with fur, hair, or smooth skin, it is carnivorous and its locomotion is fly or walk.

Karen (ESL) and Richard (ESL)

A mammal is a vertebrate that is born alive, warm blooded and it is herdivorus.
Winnie (ESL) and Sonia (ESL)

A mammal is a furry or hairy warm blooded vertebrates which lives on land. They are born alive and they breathe with lungs.

Tam (ESL) and Sean (NS)

A mammal is warm blooded has lungs and locomotion and carnivorous

Thai (ESL) and Dawn (NS)

A mammal is an animal that is born alive and breathes with lungs and lives on land.

Kevin (NS) and Kathy (ESL)

A mammal is a warm blooded vertebrate that is born alive and lives on land.

Ricardo (ESL) and Chris (ESL)

A mammal is a warm blooded specie which has lungs for its respiratory system. It also has fur or smooth skin. The Habitat is feather land or sea. Most of the reproduction systems are born alive.

Pearline (ESL) and Rudy (ESL)

A mammal is warm blooded, it is a live bearer and it breathes through lungs.

Jenny (NS) and Scott (NS)

A mammal is an animal that gives live birth and is warm blooded with lungs.

Dana (NS) and Rick (ESL)

A mammal is a warm blooded animal which has lungs and is born alive and is carnivorous. It dose not hibernate or migrate.

After examining the rough drafts of the definitions the teachers decided to spend more time helping the students develop their definitions. Groups of students brought their collective background knowledge on vertebrates to bear on the this task, as described in Chapter 3, Jenny added new background knowledge
which meant changing the language in the definition to reflect this change. Both the science and language teachers expressed that this series of activities provided an opportunity for further development of the students' academic discourse (writing and talking about vertebrate definitions) which is directly related to the knowledge structures of classification and description. Further academic discourse issues are discussed in the next section.

**Academic discourse issues**

Having examined the rough drafts of the definitions it is clear why so much time was spent developing them further. To develop language and content accuracy there seem to be at least five major areas that required attention. They included morphological and syntactical errors, rules for writing definitions, changing language to reflect content reality and stylistic conventions. Some common morphological errors were taking words like locomotion and using them this way; "... its locomotion is fly or walk." Syntactical errors were made with sentence word order and ordering adjectives to name a few examples. The next area had to do with how definitions are structured, that there is a pattern for how information is ordered in a definition and also that definitions have a purpose. Further then, the content of the definition must be accurate and if it is not, changes must be made in the language of the definition to make it so. This was illustrated above with the duck-billed platypus example. Finally, that there are stylistic conventions which are brought
to bear on writing a definition. These five areas were quite evident in the students' draft versions of their mammal definitions.

Although a much more detailed analysis of these issues could be undertaken however I think what is primary here is that the five areas mentioned above all feed into the language and content accuracy of writing definitions which is connected with the knowledge structures of classification and description.

LESSONS 5, 6 AND 7

Lessons 5, 6 and 7 were designed to allow the students to use their newly created definitions. In lesson 5 the students were presented with a revised version of the multiple record format in which the names and classes of the animals had been omitted. The students' task was to classify each vertebrate as a mammal, bird, amphibian or fish. The students had to use their definitions to justify their classification, e.g., "It must be a (certain class) because it has (these features). According to Smith and Meuxs" concept ventures this type of discourse is a sufficient condition which qualifies it as classificatory discourse. The content is the classification of vertebrates. The information is supplied on the computer. All three of these areas are related to the knowledge structure of classification.

In lesson 6 the students used the single record format to retrieve more information on other vertebrates in order to add to the database to add to the database. The content here is the descriptions of various vertebrates. The single record format
from the database is used to gather the information. These areas are related to the knowledge structures of description and classification.

In lesson 7 the students grouped the vertebrates in the database in many ways. They were able to make cross-classifications of the vertebrate database through forming questions like which of the animals are carnivorous and then determine the statement to feed the computer to get this information. The students manipulated the database to group the information in different ways referring to both the single and multiple record formats. Each of the areas are related to the knowledge structures of classification and discourse.

**SUMMARY**

It is evident from the analysis that connections exist among these three areas. Each has the organizational patterns of classification and description knowledge structures in common. The computer database has been used to organize or structure the biology content which has in turn been used to display classificatory knowledge and to promote the academic discourse of classification. Figure 4.1 summarizes the major connections among biology subject matter, a computer database and academic discourse as they relate to the knowledge structures of classification and description within the context of the unit of study on the classification of vertebrates.
**Figure 4.1** - Content, computers and language related to the knowledge structures of classification and description

<table>
<thead>
<tr>
<th>Classification</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>content</strong></td>
<td><strong>computers</strong></td>
<td><strong>language</strong></td>
</tr>
<tr>
<td>definition of vertebrates</td>
<td>multiple record</td>
<td>classificatory discourse</td>
</tr>
<tr>
<td>classification of vertebrates</td>
<td>record format</td>
<td>definition of classes</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>content</strong></td>
<td><strong>computers</strong></td>
<td><strong>language</strong></td>
</tr>
<tr>
<td>names and description of vertebrates</td>
<td>single record</td>
<td>description discourse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description**
Chapter 5

CONCLUSION

A. THE QUESTION

Can a computer database be used to augment a content based approach to developing academic discourse? This document has reported on the integration of these three areas in student tasks in a unit of work (biology). The objectives of the study were: 1) to investigate the connections between biology content, a computer database and the academic discourse of classification and 2) to identify if each of these areas were in fact related to the knowledge structures of classification and description.

B. SUMMARY OF FINDINGS

1. Chapter 3 - Narrative

Chapter 3 provided the context for examining objective 1 above, the connections between biology content, a computer database and the academic discourse of classification. Three areas were focussed on: how a database and biology materials are related, how student tasks can be related to classification and how the resulting discourse is classification discourse. It appears quite clear from the narrative of the unit that a database can be used to organize biology material on the classification of vertebrates. The students used the vertebrate database to do a number of classification type tasks. Two of special note were writing definitions of the vertebrate classes and then classifying other vertebrates using those definitions. The written and spoken discourse that occurred during these tasks was classificatory in nature according to Smith and Meux's categories of discourse.
2. Chapter 4 - Analysis

The purpose of Chapter 4 was to examine the relationships between biology content, a computer database and the academic discourse of classification and the knowledge structures of classification and description. This analysis accounts for the second major objective of the study.

From the analysis it is apparent that there are connections among these three areas. Each of the areas has the organizational patterns of the knowledge structures of classification and description in common. As mentioned at the end of Chapter 4 the vertebrate database has been used to organize or structure the biology content which has in turn been used to display classificatory knowledge and promote the academic discourse of classification. The results of this study are summarized in Figure 4.1. It is evident that connections among biology subject matter, a computer database and academic discourse as they relate to the knowledge structures of classification and description exist within the context of this unit of study on the classification of vertebrates.
Figure 4.1 - Content, computers and language related to the knowledge structures of classification and description

<table>
<thead>
<tr>
<th>Classification</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>content</td>
<td>computers</td>
<td>language</td>
</tr>
<tr>
<td>definition of vertebrates</td>
<td>multiple</td>
<td>classificatory</td>
</tr>
<tr>
<td>classification of vertebrates</td>
<td>record</td>
<td>discourse</td>
</tr>
<tr>
<td></td>
<td>format</td>
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</tr>
<tr>
<td>content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>names and description of vertebrates</td>
<td>single</td>
<td>description</td>
</tr>
<tr>
<td></td>
<td>record</td>
<td>discourse</td>
</tr>
<tr>
<td></td>
<td>format</td>
<td></td>
</tr>
</tbody>
</table>

C. IMPLICATIONS FOR RESEARCH

The data seems to suggest that biology subject matter, a computer database and classificatory discourse have patterns of information organization which are similar to the patterns of organization in the knowledge structures of classification and description. This conclusion is applicable only for this study and is not necessarily generalizable to other teaching and learning contexts, however the relationship between these three areas appears to be strong enough to act as a reference point for a number of related research issues. I think a reasonable and pivotal direction to move in is to examine quantitatively the effects of integrated biology content, computer database and classificatory discourse unit of study on cognitive academic language development and academic achievement. All of the other research implications and suggestions for instruction will use the findings as a reference point for enquiry. They are all in some ways examining means by which CALP and academic achievement
can be fostered. While these issues overlap each other extensively, in order to discuss them more easily I have grouped them into three general areas:

1. Task design and its relationship to learning content and language.
2. Teacher planning and organization of a unit of study.
3. Tool applications of the computer: the database, spreadsheet, and decision making software

For each of the three areas above I will describe a few pertinent issues which arose from the data.

1. Task design and its relationship to learning content and language

There were two issues which have particular relevance to this topic:

a) The value of integrating content, computers and language. Does it make learning for the student more meaningful and efficient for the learner?

In lesson 4 the students were composing definitions of vertebrates. If one student suggested some information on a particular vertebrate which did not agree with its respective definition, the students then looked for ways to include the information in their definitions. This often meant restructuring the definition. The students were eager to make their definitions precise. The teachers were able to introduce the students to language structures which made their definitions more accurate. For example instead of introducing the students to relative clauses in a language arts class unrelated to a content area, the biology content provided a context in which the students wanted to know what language input they needed in order to improve their
definitions. At this point I think learning about relative clauses became relevant the students. While these are only observations on my part, they do support examining the differences in how meaningful a situation like the one above is to students compared to one where these three variables are taught as separate entities. Further to this it would be interesting to note how each of these methodologies differ with respect to how efficiently and effectively the students learn.

b) Do descriptors as they have been used here in a database make a significant difference in how students learn content and language? For example do the descriptors provide a point of reference for the students' learning throughout the unit?

The descriptors were used in lessons 2-7 for several different tasks. By the time the students reached lesson 6 where they researched other vertebrates using the descriptors as a retrieval sheet they were very familiar with the descriptors. The science teacher reported that the students were able to collect information on vertebrates accurately and efficiently and had improved in their ability to do this kind of task.

When comparing Parts I and II of the unit the language specialist said that in her experience the unit really took off when the descriptors were focussed on in lesson 2.

I observed students using the descriptors in the retrieval sheet not as a simple fill in the blank exercise but one that appeared cognitively demanding. For example textual material did not always mention if certain mammals were warm blooded or cold blooded, however the students knew that mammals were warm blooded
so they were able to fill this in based on their background knowledge.

2. **Teacher planning and organization of a unit of study**

For this area two issues were particularly relevant:

a) Teacher fronted lessons versus teacher guided lessons. What are the differences for teachers and students who have respectively taught and learned in a teacher fronted class as compared to a class which is not teacher fronted as is the case here.

In this unit, out of 20 lessons, approximately two were teacher fronted and the rest were orchestrated in such a way that the students worked in pairs or in small groups using the database as a source of information to do a variety of tasks. The teachers acted as guides and facilitators. The students were active participants in their learning. I think it would be worthwhile to examine the roles of both the teachers and students in this situation and determine if this type of arrangement has a positive affect on learning.

b) The science and language specialist teachers were partners in planning and teaching this unit. Was this partnership beneficial to the teachers and the students?

Traditionally English Language Centre (ELC) teachers withdraw ESL students from their content classes in order to teach them language. Even when ELC teachers are teaching content it is not necessarily the same content the student is missing in his absence. In this unit of work the ELC teacher joined the content teacher in teaching the science unit. Rather than spending time with a few students who were drawn out of class the ELC teacher
worked with the entire class on language issues related to science content. The teachers were able to work cooperatively, each bringing their own strengths to bear on the planning and teaching of the unit. How might this type of partnership benefit the teachers and the students?

3. Tool applications of the computer: the database, spreadsheet, and decision making software

At least two areas of interest arose from the data:

a) Since connections appear to exist between biology subject matter, a computer database and classificatory discourse it may possible that connections exist between other content areas such as social studies or mathematics and a computer database and classificatory discourse. Units could be planned, as the one in this study was, to provide a context to examine the connections between these content areas and a computer database and classificatory discourse.

b) Finally, are there other tool applications of the computer which can be related to the other knowledge structures of principles, sequence, evaluation and choice in Mohan’s knowledge framework? A spreadsheet program can be used to test if-then relationships. These are related to cause-effect relationships which are connected to the knowledge structure of principles. Decision making programs exist which appear to be related to the knowledge structures of evaluation and choice.

Can these application be used as key visuals to bridge between content and language and acts as a support for cognitive/academic development?
The preceding discussion is a brief overview of some of the possible areas that might be researched related to the connections between biology subject matter, a computer database and classificatory discourse.

D. SUGGESTIONS FOR INSTRUCTION

This unit both in preparation and execution pulled together a wide array of variables and provided a rich source of data from which many issues arose. Out of the data I have chosen to discuss two issues related to instruction.

1. Improvements to the vertebrate database

While the database served well as source of information on vertebrates and was used as encourage classificatory discourse it was not without its faults. For example as the database exists there are very few physical descriptors, which would make it difficult for anyone to assemble a mental image of the animal. This might be rectified by adding descriptors like size, weight and color.

A second improvement would be to add a visual of the vertebrate in the database so that it might be called up with the vertebrate’s record. I think this would make the descriptors more meaningful to the student when they can see an example of what they are reading about.

Thirdly, by adding descriptors which divide the vertebrate classes by genus and species the number of different task design possibilities is increased.
2. **How the database might be used differently**

While I think the descriptors played a pivotal role in the unit, it did take some time for the students to really understand them, which meant that the unit did not proceed as well for some students. In order to improve this situation the science teacher has suggested some preparatory work which would involve the students observing shore creatures, describing them, developing their own descriptors, designing a database, entering their information in the database and finally performing classificatory tasks using the database. The students would then be in a better position to understand the function of the descriptors in the vertebrate database.

If the computer database was improved and included physical descriptors, genus and species descriptors, and visuals of the animals then a variety of new tasks could be designed to take advantage of these changes.

The above suggestions for improving the database are also prime areas to investigate in a research context.

**E. A FINAL WORD**

The major focus of this unit has been to examine if biology content, a computer database and the academic discourse of classification are related to the knowledge structures of classification and description. The findings suggest that these three variables are connected. I have discussed possible research directions and instructional suggestions which have arisen from the data. It is my hope that this study will become a part of a growing body of research which is concerned with examining ways
to improve cognitive academic language proficiency and academic achievement for native and non-native speakers of English.
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I Descriptive Moves

1. Characteristic. A single characteristic of a referent is explicitly noted or discussed.

2. Sufficient condition. A statement of properties or set of conditions is given as being sufficient to identify something as an instance of the referent.

3. Classification. A group of which the referent is a sub-group is noted or discussed.

4. Classificatory description. The referent is mentioned and described as a particular sub-class of a given class.

5. Relations among characteristics. Two or more characteristics are functionally related so that when one characteristic is varied (usually called an independent variable) the effect of the change upon other characteristics (usually called the dependent variable) can be noted and discussed.

6. Analysis. A set of parts which together make up a referent is noted or discussed.

II Comparative Moves

7. Analogy. The referent is said to be like something else. How the referent is like something else may be noted or discussed, or the referent may be said to be like something else, but there is no discussion of how the referent is like it.

8. Differentiation.
   8.1 The different between the referent and something else is noted or discussed, or the relationships between the referents of two primary concepts are noted or discussed.
   8.2 What the referent is not, or that it is not the same as something else, is noted but there is no discussion of how the referent is not the same as the other thing.
   8.3 The opposite of the referent is mentioned or discussed.

9. Instance comparison. The similarities or differences between two or more instances or sub-classes of the referent class are noted or discussed.
III Instantial Moves

10. Positive instance. An instance or sub-class of the referent is noted or discussed.

11. Instance enumeration. All instances or sub-classes of the referent are noted or discussed.

12. Negative instance. Something that is not an instance or sub-class of the referent but is similar enough to be mistaken for one, is noted or discussed.

13. Instance production. How an instance or sub-class of the referent is produced, or how it develops, is noted or discussed.

14. Instance substantiation. The reason or evidence for concluding that a designated instance is an instance of the referent class is given or discussed.

IV Usage Moves

15. Meta distinction. The different uses of a term, the different meanings of a term, or the different conditions associated with a term.
APPENDIX B - Lesson Plans

SCIENCE 7 - CLASSIFICATION OF VERTEBRATES

Suggested sequence and content of activities

LESSON 1 - aim: review - groups living things are classified by

1. Key Visual - Living Things

a) get students to generate each level

```
  living things
   |   |
  animals non-vertebrate
  /    \
vertebrate
```

b) brainstorm - names of animals - insects - put into two groups - get students to show difference

c) what other animals have vertebra - backbones - add to list

d) ask students to generate the major classes of the vertebrates - fill in if they leave some out - fill in 1 or 2 examples

```
vertebrate
mammals  |  birds  |  reptiles  |  amphibians  |  fish
  dog     |  robin  |  snake    |  frog        |  salmon
human    |  lizard |  salamander
```

LESSON 2 - aim: for students to develop generalizations about the 5 types of vertebrates to aid them in classifying vertebrates

2. mammals  |  birds  |  reptiles  |  amphibians  |  fish
a) ask students to suggest what characteristics vertebrates have in common, e.g., skin covering - have student work in groups to do this

b) have one student report their set of characteristics (from each group) - teacher jots down - puts similar descriptors together - help focus

c) Student exercise. Instructions - Read this exercise carefully and supply the missing information. You may have to consult a dictionary.

<table>
<thead>
<tr>
<th>DESCRIPTORS</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ________</td>
<td>cold/warm blooded</td>
</tr>
<tr>
<td>2. respiratory system</td>
<td>, ,</td>
</tr>
<tr>
<td>3. skin covering</td>
<td>, , ,</td>
</tr>
<tr>
<td>4. ________</td>
<td>born alive, eggs</td>
</tr>
<tr>
<td>5. appendages</td>
<td>legs, , ,</td>
</tr>
<tr>
<td>6. habitat</td>
<td>, ,</td>
</tr>
<tr>
<td>7. hibernation</td>
<td>, , ,</td>
</tr>
<tr>
<td>8. locomotion</td>
<td>, ,</td>
</tr>
<tr>
<td>9. migration</td>
<td>, ,</td>
</tr>
<tr>
<td>10. diet</td>
<td>, ,</td>
</tr>
</tbody>
</table>
d) In pairs students order the descriptors from the most significant to the least significant in showing the differences among the five classes of vertebrates.

1. ______________________  6. ______________________
2. ______________________  7. ______________________
3. ______________________  8. ______________________
4. ______________________  9. ______________________
5. ______________________  10: ______________________

LESSON 3 - Students working in pairs
e.g., (NS NS) (NNS NNS) (NS NNS)

Students fill in a chart using a data base on vertebrates. (Select two animals from each class.)

<table>
<thead>
<tr>
<th>Name</th>
<th>class</th>
<th>body temp.</th>
<th>resp.</th>
<th>skin</th>
<th>reprod.</th>
<th>etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mammal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mammal</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bird</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bird</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Have students get their grids checked.
LESSON 4 -

1. Students then compare and contrast the characteristics of the vertebrates. List the examples of the descriptors which are unique to each class. Using these examples write a definition for each of the vertebrate classes, e.g., "A Mammal has ....."

2. How are the classes similar to each other? List similarities, e.g., Mammals and birds are warm blooded.

LESSON 5 - Data Base Classification Activity - Vertebrates

This data base includes only the characteristics of the animals. The class has been left out. Read over the characteristics of the animal and then refer to your definitions. Fill out the chart below indicating name, class (mammal, bird, amphibian, reptile, fish) and why you think it belongs to this class.

<table>
<thead>
<tr>
<th>Name of Animal</th>
<th>Class</th>
<th>Why you think it belongs to this class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. cat</td>
<td>mammal</td>
<td>warm blooded, has fur</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
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<tr>
<td>7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LESSON 6 - Library Research

1. Prepare 5 index cards as follows:

   Name: ____________________________
   Class: ___________________________
   Body Temp.: ______________________
   Covering: _________________________
   Resp.System: _____________________
   etc.

2. Select 5 animals, one from each class. Do not use the animals on the chart. Show your list to the teacher. At the library research each animal and fill out an index card.

   a) load the data base "Vertebrates"
   b) go to the end of the records
   c) type in the information

LESSON 7 - Vertebrate data base activities:

1. a) Give examples to students of what you can pull out of a data base, e.g., a list of all the mammals; an alphabetical list of each class - each of these are classifications

   b) Demonstrate how information is retrieved - rules for retrieval (and/or etc.)

   c) Supply the students with questions, e.g., "Which animals are carnivorous?" and the selection rules - class = carnivorous - to get the information.

   d) In groups have students develop five questions to ask of the data base and the accompanying rules for getting the questions.

   e) Students report to rest of class using a chart or bulletin board to show their results.

2. a) Alternate activity - have students build a trivial pursuit game which involves using the data base.
## APPENDIX - C 75 Vertebrates

### Mammals
- duck-billed platypus
- wallaby
- shrew
- horseshoe bat
- orangutan
- pangolin
- prairie dog
- musk-rat
- dingo
- cheetah
- wolverine
- grizzly bear
- beluga whale
- african elephant
- three-toed sloth

### Birds
- ostrich
- king penguin
- flamingo
- mallard
- swan
- cuckoo
- owl
- king fisher
- woodpecker
- cockatoo
- vulture
- eagle
- kiwi
- stork
- secretary bird

### Amphibians
- toad
- arrow-poison frog
- firebelly
- mud puppy
- newt
- axolotl
- brown spelerpes
- alpine newt
- greater siren
- olm
- amphiuma
- bull frog
- marsh frog
- tiger salamander
- caecilian

### Reptiles
- alligator
- tuatara
- box turtle
- terrapin
- crocodile
- adder
- komodo dragon
- iguana
- indian cobra
- chameleon
- anaconda
- boa constrictor
- gecko
- moluccan skink
- viviparous lizard

### Fish
- bluefin tuna
- lungfish
- great white shark
- sea lamprey
- swordfish
- sardine
- goldfish
- piranha
- flying fish
- dragonfish
- goby
- electric eel
- atlantic salmon
- seahorse
- sea-perch