SUPPORTING ESL LEARNERS' LANGUAGE AND CONTENT DEVELOPMENT IN A DIGITAL ENVIRONMENT

by

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ABSTRACT

The research question asked, can a Knowledge Framework based model of computer environments support English Second Language students in using Internet information to develop content knowledge and cognitive academic language skills?

In the rapidly expanding digital world, students are able to locate and access vast amounts of information. The challenge to teachers and students is to select, organize and make productive use of this information. The research investigated student writing composed in a customized computer writing environment which included windows for instruction, graphics, text and Internet information designed to help students develop their academic language skills and consolidate their content knowledge. Analysis of student work explored how the students had used the resource windows to create their reports and graphics and how their writing evidenced 'academic discourse'. Analysis traced the selection and transformation of information gathered from the Internet through the students' notes and graphics to their final product. The analysis considered the degree to which the knowledge structures inherent in the information resources and graphic tasks were represented in the students' written samples.

The study was based on an examination of regular school work undertaken by a group of ten elementary second year ESL students in a sheltered class. Students worked under the supervision of the teacher/librarian, classroom teacher and computer support teacher on a collaboratively developed Marine Mammals unit. Although the implications of this research are limited by the small number of students involved, the selection of a conventional content theme and the general issues of support for ESL students in developing language and content skills, as well as appropriate strategies for the educational use of Internet information expand the application of the results.

The analysis of student work showed that ESL students were able to use the digital environment to successfully identify, record, consider and present collaboratively researched Internet content. In addition to teacher support and instruction, elements of the task design identified as most critical to students' content and language learning included the use of knowledge structure appropriate key visual tasks connected to notetaking and language supports.

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INTRODUCTION

A. Research Question

Can a Knowledge Framework based model of computer environments support English Second Language students in using Internet information to develop content knowledge and cognitive academic language skills?

This question explored ways to support teachers and students in making best use of Internet information resources. It has been observed that students are able to access vast amounts of information on the Internet but that helping students identify, select and reflect on that information is a more challenging task. One aspect of the problem was to design learning tasks to make student Internet access more meaningful and productive. A related aspect was how to provide students with a research and recording environment that would reduce the enticement to plagiarize material and would increase the opportunities for students to work with and understand the information they gathered. The goal was to design a task environment which could help consolidate students' content learning and encourage authentic writing.

B. Methodology, Setting and Limitations

This paper will examine English Second Language (ESL) student writing composed in a customized computer writing environment which included windows for instruction, graphics, text and Internet information. The goal of this computer environment was to help students develop their academic language skills and consolidate their content knowledge. Analysis of student products will use discourse analysis techniques from functional linguistics to study how students have used the resource windows to create their reports and how their writing evidences 'academic discourse'. Analysis will trace the use and development of information gathered from the Internet through the students' notes and graphics through to their final written product. The analysis will also consider the degree to which the knowledge structures inherent in the information resources and graphic tasks were represented in the students' written samples.

Finally, the paper will discuss how computer displays can provide access to multiple representations of data, how student writing and language development may be supported in such an environment, and how this type of computer environment is related to changes and directions in the computing world. The hypothesis is that student texts produced using Knowledge Framework based data gathering structures will show content-appropriate organization and academic cognitive textual language.

The study is based on an examination of regular school work undertaken by a small group of elementary second year ESL students in a sheltered ESL class. Students worked under the supervision of the teacher/librarian, classroom teacher and computer support teacher on a Marine Mammals unit. The topic and main learning objectives for this unit were developed collaboratively by the ESL homeroom teacher and the teacher/librarian. The learning tasks and their computer representations were developed by the researcher in collaboration with the classroom teacher and the teacher/librarian. Students' individual and group work was observed in the library, Internet computer lab and regular computer lab. Although the implications of this research are limited by the small number of students involved, the selection of a conventional content theme and the general issues of support for ESL students and of appropriate strategies for the educational use of Internet information expand the application of the results.

C. Research Context

This study is informed by a number of related research areas: language socialization; second language teaching and learning; task-based learning; computers in second language education and connections between knowledge structures and reading schema and writing genres.

Language Socialization

In general terms, this paper draws on research in the field of language socialization which recognizes the communicative or functional aspects of language and applies these aspects to interpreting language learning tasks in the social context of second language classrooms in an English first language culture.

The link to language socialization is important as it distinguishes this study from the field of second language acquisition and its focus on acquiring linguistic competence. Schieffelin and Ochs show that "language socialization, which focuses on how children are socialized through the use of language as well as how children are socialized to use language, can further our understanding of the functional and symbolic interface between language and culture" (1986: 184). In the present study, the understanding relates to the social situation of ESL students in English first language schools. These students are simultaneously learning language, content and the cultural expectations of the school system. The elements of the situation are interdependent and thus an examination of the context of the situation is appropriate. Implications of the study are also relevant to students generally as learning tasks related to content and academic discourse are issues of wider concern in education.

Second Language Teaching and Learning

The definition and understanding of academic discourse is based on the distinction between conversational and academic language proficiency articulated by Cummins (1984, 1991). For the purposes of the present case study, development of academic language skills is one of the teaching and learning objectives identified by the classroom teacher and incorporated into the design of the students' learning tasks. The success of both the students and of the task design in supporting academic language growth will be examined. Although Cummins notes that his theoretical position has been controversial (1991:75), it has contributed to research which provides evidence of the long term necessary for ESL students to acquire the peer level academic language skills necessary for success in schools (Collier, 1987; Saville-Troike, 1984). Cummin's research contributed to Mohan's (1986) work on language and content which is further linked to ongoing work in ESL instruction in the Vancouver School District. In the school district generally and in the research setting specifically, Mohan's Knowledge Framework has been applied to the creation of units of study which seek to integrate student learning objectives for both language and content. Mohan's work is also related to the field of language socialization and a functional model of language as expressed by Halliday (1975, 1985). Within this tradition, language is seen not as an isolated

object for use or study, but rather as an integral part of the social setting in which it develops and which it also reflects. In Halliday's and Hasan's terms, "a text is essentially a semantic unit" (1985:10) and must be interpreted as both an object and as "an instance of social meaning in a particular context of situation" (1985:11). In educational settings, student texts are products of the educational process and may be examined to reveal aspects of the text and of the situation. This case study will use both functional linguistics and knowledge structures to explore the development of student texts in a digital and social environment.

Knowledge Structures, Schema Theory of Reading & Genre Theory of Writing

Concepts which informed the task designs for notetaking and graphics were also related to knowledge structures and through them to ideas drawn from reading schema theory and writing genres. Mohan (1991) identifies two connections between these theories. First, that a framework of knowledge structures underlies most of the text structures discussed by proponents of a schema theory of reading. Second, that the same framework of knowledge structures also underlies many of the genres discussed by proponents of genre approaches to writing. Thus, the text structures present in written texts relate to more abstract knowledge structures. In this thesis, Mohan's framework is used to mediate or bridge student reading tasks and writing tasks. This is accomplished in the design, execution and interpretation of the following task structure: students use notetaking strategies based on knowledge structure to extract meaning from their reading of Internet information; they then use meanings organized around these knowledge structures as a basis for their writing tasks. When students create a text from meaning organized around a knowledge structure, they create discourse texture. Mohan (1989), views the creation of discourse texture in terms of Halliday's systemic functional analysis of discourse and the Australian analysis of expository writing based on Halliday's work. In other words, as abstract semantic structures, knowledge structures lack discourse texture, which concerns such matters as thematic organization.

Recent reading research has investigated the interaction between textual structures and formal and content schemata on reading comprehension. Carrell (1985) reviews research on text structures and reading for both first and second language students. She cites five English

first language studies which showed significant improvements in reading comprehension when students were explicitly taught about text structures and taught strategies for recognizing and using structures as reading aids. As background to her own study, Carrell notes that "researchers have suggested that teaching various aspects of text structure ought to facilitate ESL reading comprehension ... and some have even suggested a variety of pedagogical techniques to do this teaching most effectively - including text-mapping strategies ..." (1985:734). In her study, senior ESL students were taught to recognize four expository text-types identified by Meyer (1975) and to use this knowledge to help them complete the analysed recall procedures. She concludes that "overt teaching about top-level rhetorical organization of texts can facilitate ESL students' reading comprehension" (1985: 741). In a more recent paper, Mohan (1991) has related Meyer's text types to Knowledge Structures which informed the design principles of the present study. Mohan reviews a number of studies which show how graphic representations facilitate comprehension and discusses how various studies in metacognition and reading strategies for content and structure influence comprehension and proficiency.

Although specific teaching of text structures was not an objective or strategy employed in this unit, the design of the notetaking tasks (textual and graphical recording) drew on an awareness of the both the likely content and structure of Internet information resources to facilitate ESL student's reading comprehension and recording ability. In making knowledge structures applicable to the content and structure of the resource text explicit in notetaking prompts and key visual organizers there was a presumption that students' notes and comprehension would be enhanced and that their writing would be supported.

Writing supports incorporated into the task design were also related via knowledge structures to genre theories of writing based on functional linguistics. The research and application of genres within school writing programs has been a significant feature of recent Australian education (Martin & Rothery, 1986). Although specific and detailed teaching of expository genres as outlined in the Australian models was not an objective of the unit, supporting beginning factual writing with ESL students was a goal. To this end, the project

used knowledge structures expressed in key visual organizers and the structures and language supports included in the students' notebook window to underpin the 'stages, goals and social purposes' of an expository genre. As in the Australian experience, part of the goal was to make the elements of factual writing explicit to both teachers and students and to make the use of appropriate language and grammar a functional part of the student's work space and task. Elements of systemic functional linguistic analysis related to discourse semantics, particularly conjunction, and to textual meaning when interpreted as theme and rheme are applicable to this project. However, it should be noted that the Australian genre work does not yet make explicit use of knowledge structures.

Task-based Learning

The Marine Mammals unit and the research organized around it are also based on the concept of task as a fundamental unit appropriate to curriculum studies. This view is derived from Doyle (1983) and Doyle and Carter (1984) who define school curricula as "a set of academic tasks that students encounter in classrooms" (130). They discuss how this concept of task is based on cognitive psychology and anthropology and how it agrees with general student and teacher perceptions about the way classrooms and assignments work. Concepts of task as defined by second language researchers will also be discussed and applied to the computer representation of language and content learning tasks used here.

Computers in Second Language Education

A final field of research applicable to this study is that of computers in second language education. Research questions in education and information technology generally, and in computer-assisted language learning specifically, are changing with the changes in the digital world and with the historical development of a field of study. The present study will be related to these changes and to trends in the use of information technology in education.

CHAPTER 1: REVIEW OF THE LITERATURE

A. Academic Discourse & The Knowledge Framework

Introduction & Language Socialization

The approach to second language learning followed in this paper and in the research setting is drawn broadly from the field of language socialization and acknowledges the degree to which second language development is an interactive and intercultural process. From this perspective, the goal of developing ESL students' academic language proficiency is recognized as critical to the students' future success in the English first language school system. This language development goal was also identified in the Inner City Project School designation of the research setting which articulates a belief in providing equitable educational outcomes for inner city children. Within the larger field of language socialization the Marine Mammals unit and the accompanying research are based on Mohan's language and content approach to second language learning.

The link to language socialization is important as it distinguishes this study from the field of second language acquisition and its focus on acquiring linguistic competence. Schieffelin and Ochs show that "language socialization, which focuses on how children are socialized through the use of language as well as how children are socialized to use language, can further our understanding of the functional and symbolic interface between language and culture" (1986:184). In the present study, this understanding relates to the social situation of ESL students in English first language schools. These students are simultaneously learning language, content and the cultural expectations of the school system. The elements of the situation are interdependent and thus an examination of the 'context of the situation' is appropriate.

The description of the setting and the research context is also related to studies of language in anthropology and sociology particularly those reported by Malinowski who argues for the importance of considering situation in studying discourse: "An utterance becomes only intelligible when it is place within its *context of situation*, if I may be allowed to

coin an expression which indicates on the one hand that the conception of *context* has to be broadened and on the other hand that the *situation* in which words are uttered can never be passed over as irrelevant to the linguistic expression" (1923:306). Malinowski's views on the context and functions of language form part of the academic background to the field of sociolinguistics and functional linguistics which will be discussed in a subsequent section.

Academic Discourse

The definition and understanding of academic discourse used here is based on work by Cummins (1984, 1991) which compares first and second language learners' academic development in bilingual situations. In his 1991 paper Cummins reviews data that have the potential to either confirm or challenge his three "theoretical constructs" (1991:75): i) the "distinction between conversational and academic aspects of language proficiency"; ii) "the interdependence hypothesis"; and, iii) "the threshold hypothesis" (1991:86). He notes that these ideas have been controversial and concludes that the first two are well supported by recent studies and that, while the threshold aspect of the third may be incorrect, the value of bilingual education is still associated with positive cognitive outcomes. For our purposes it is appropriate to briefly outline the first two concepts and to support Cummins claim that his constructs "address issues of immediate relevance to policy and practice in the education of bilingual students" (1991:76). This latter claim is borne out by the influence Cummins' ideas, along with those of Collier and Mohan, have had on ESL policy directions of the Vancouver School Board over the last decade. These policies have sought ways to support ESL students over longer periods and also to support students in the acquisition of academic or school language not just in the acquisition of conversational fluency. These policies included professional development components which were part of the background for the present research.

Cummins research on language proficiency has evolved since 1979 and the terms conversational and academic proficiency have replaced the earlier 'basic interpersonal communicative skills, BICS', and 'cognitive academic language proficiency, CALP' acronyms. The distinction between these terms is not contained within a simple polarity but "was

elaborated into two intersecting continua which highlighted the range of cognitive demands and contextual support involved in particular language tasks or activities (context-embedded/context-reduced, cognitively undemanding/cognitively demanding)" (1991:78). Cummins shows how the conversational/academic language proficiency distinction is supported by empirical research in linguistics (Biber, 1986) and by his and others research into rates of academic language acquisition (Cummins, 1981; Saville-Troike, 1984; Collier, 1987, 1989). This research provides evidence of the long term, four to eight years, required for ESL students to approach peer level cognitive-academic language skills compared to approximately two years to acquire conversational fluency.

Cummins interdependence hypothesis suggests a positive correlation and transfer between first and second language (L1 and L2) literacy skills and implies "that L1 and L2 academic skills were manifestations of a common underlying proficiency" and "that what is transferred is primarily conceptual knowledge rather than specific linguistic elements" (1991:77).

Both of these concepts are related to the purposes of the present case study. The development of academic language skills was one of the teaching and learning objectives identified by the classroom teacher and incorporated into the design of the students' learning tasks. These tasks sought to enhance ESL students' academic language development by providing contextual supports for working with cognitively demanding texts on the Internet. Too, indirect support for the interdependence hypothesis may be evident as the students involved in the study represented a range of first language academic experiences from minimal prior schooling to schooling equivalent to that in Canada.

Language & Content and the Knowledge Framework

Cummin's research contributed to Mohan's (1986) work on language and content which is further linked to ongoing work in ESL instruction in the Vancouver School District. In the school district generally and in the research setting specifically, Mohan's Knowledge Framework has been applied to the creation of units of study which seek to integrate student learning objectives for both language and content. Mohan's work is also related to the field of

language socialization and a functional model of language as expressed by Halliday (1975, 1985). Within this tradition, language is seen not as an isolated object for use or study, but rather as an integral part of the social setting in which it develops and which it also reflects. In Halliday's and Hasan's terms, "a text is essentially a semantic unit" (1985:10) and must be interpreted as both an object and as "an instance of social meaning in a particular context of situation" (1985:11). In educational settings, student texts are products of the educational process and may be examined to reveal aspects of the text and of the situation. This case study will use both functional linguistics and knowledge structures to explore the development of student texts in a digital research environment incorporating the Internet and in a generally typical, Canadian school social environment. A brief discussion of some of the links between Mohan's work and research in language socialization and academic discourse have already been noted. A more detailed examination of Mohan's model and its theoretical base follows.

Mohan's Knowledge Framework (1986) is a model for integrating language and content learning with second language theory and research and classroom issues. Mohan's work starts from a desire to develop "an adequate model of contexts" (1986: v) related to a 'communicative' approach to language teaching.

> Current views of language teaching can be broadly termed "communicative". Communicative or functional language teaching derives from a functional or contextual view of language which relates discourse to extralinguistic context or situation (as contrasted with a formal view of language as an abstract system) (1986:v)

In developing a model of contexts, Mohan addresses issues related to the role of nonlinguistic knowledge in understanding discourse, to the role of discourse in learning activities, to identifying a framework to link knowledge and activity and to relating activities to discourse (1986:v-vi). The framework consists of six 'knowledge structures' representing both the background or theoretical knowledge and the active or practical knowledge in a situation. Each knowledge structure is related to cognitive processes, to associated language and to nonlinguistic or graphic representations of the content. The following table summarizes these elements of the framework and gives a simple example of each element:

Table 1.1 - Knowledge Framework

BACKGROUND KNOWLEDGE	CLASSIFICATION	PRINCIPLES	EVALUATION
Cognitive processes → Language → Graphics →	classify, define belongs to, usually trees, tables	interpret, explain thus, probably diagrams	evaluate, recommend like/dislike rating tables
Cognitive processes → Language → Graphics →	observe, describe similar to, made of pictures, maps	sequence, order first, finally, above strips, flow charts	decide, select should, rather decision trees
PRACTICAL SITUATION	DESCRIPTION	SEQUENCE	CHOICE

The Knowledge Framework works as both a research and teaching/learning tool which fills a need identified in language education and education generally: "What is needed is a integrative approach which relates language learning and content learning, considers language as a medium of learning and acknowledges the role of context in communication" (1986:1).

Based on the Knowledge Framework, Early, Mohan and Hooper developed the Vancouver School Board's 'Language and Content Project' and created a teacher inservice program titled "A Framework for Teaching and Learning" (1987, 1990). This Framework is based on second language research applied to seeking ways to help teachers and students integrate language learning with learning in other subject areas. In the teacher inservice program, these assumptions are expressed as beliefs which will guide teachers in the way they teach second language students:

> 1. We must find ways to support all students' academic and cognitive development while they are in the process of acquiring English.
>
> 2. It may take, and indeed, is likely to take, many years of support beyond the ESL classroom to develop the kind of language necessary for academic achievement.
>
> 3. A program that integrates language and content teaching is necessary to help students be successful in the mainstream classroom.
>
> 4. 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: students acquiring English need planned help with their real needs in coping with the language demands of learning in a school context. (1987).

The 'Framework for Teaching and Learning' offers teachers an understanding of the 'Knowledge Framework', an introduction to the use of 'Key Visuals' and an outline for designing learning tasks which will support students through four stages of an academic task model. The stages can be stated as student and teacher actions: 1. Building background knowledge; 2. Thinking through the topic; 3. Reconstructing knowledge; 4. Presenting and applying knowledge.

B. Task-based Language Learning and Teaching

Introduction

The organization and design of the Marine Mammals unit and of this research are also based on the concept of task as a key organizing unit for curriculum study. The literature review presented here will discuss how task is variously defined in the literature; how the various definitions relate to each other and how they relate to second language teaching and learning.

Task as a unit of curriculum analysis begins with an article by Walter Doyle (1983) in which he sets out the basic definition developed by later writers. For Doyle, "the curriculum consists of a set of academic tasks that students encounter in classrooms" (1984:130). This view of curriculum is important for it defines a unit of analysis available to researchers which coincides with a view of school work commonly held by teachers and students. Equally important is the idea that tasks inform teachers' organization of curricula and students' actions and thoughts about schoolwork. "An analysis of academic tasks would seem to be a promising approach to understanding how teaching effects occur in classrooms. First, the concept of task connects student information processing with environmental conditions. Knowing the task students are working on gives access to the kinds of cognitive processes that are likely to be necessary to accomplish the task. Second, a task is more than just content. It also includes the situation in which content is embedded" (1983:162). Doyle's concept of task is quite broad as it includes students, the classroom context and how that context is managed by teachers. Doyle and Carter further examine the nature of tasks in the classroom environment and note that students relate tasks to the evaluation system and respond to the

ambiguity and risks levels inherent in the task conditions. Teachers task involve not only the design of academic or pedagogical tasks, but also the design and management of the environment and the guidance and management of the students.

Doyle and Carter's concept of task is very broad but is clearly and closely related to the pragmatic reality of classrooms. Doyle's concept of task is important for it links student thought and action within a definable and researchable unit. The studies discussed by Doyle are concerned with traditional classrooms and curricula rather than second language issues but the concept of task he developed has been recognized and used by researchers concerned with second language teaching and learning.

Task-based language learning and teaching

In the second language field, a number of interesting definitions and analyses of task have been published. Michael Long (1985) sets out an early definition where " 'task' has no more or less than its everyday meaning ... as a piece of work.... (89). Long condemns what he sees as the traditional route to second language curriculum creation by separately defining language syllabus and teaching methods and further criticizes the overt or covert focus on linguistic units and the assumed connection between linguistic or sociolinguistic units and units meaningful to the learners. Long argues "that task is meaningful and viable unit of analysis in all four of what I take to be the major issues in programme design:

(i) identifying learners' needs,

(ii) defining syllabus content;

(iii) organizing language acquisition opportunities,

(iv) measuring student achievement. (89)

The steps outlined for creating a task-based syllabus are:

1. Conduct a needs analysis to obtain an inventory of *target tasks.*
2. Classify the target tasks into *task types.*
3. From the task types derive *pedagogical tasks.*
4. Select and sequence the pedagogical tasks to form a *task syllabus.*

Long offers suggestions which will overcome "the tendency for developments in syllabus design and teaching methodologies to occur independently of one another, and both independently of psycholinguistic research." (95-96). He suggests that task-based language teaching "is provided as an example of what an integrated, psycholinguistically based solution might look like." (96). Much of Long's paper then reviews other psycholinguistic proposals for language teaching, particularly Pienemann and Krashen, and dismisses them as incomplete or incorrect for contradictions in the empirical evidence or for designing a programme around one issue in contrast to his view of task-based as inclusive of major issues relating to language acquisition tasks.

While this case study was not concerned with the development of an entire task-based syllabus, in general terms it followed the first three steps outlined by Long as appropriate for creating task-based syllabuses.

Crookes (1986) undertakes a 'cross-disciplinary review' of task and expands Long's definition by declaring task to be "a piece of work or an activity, usually with a specified objective, undertaken as part of an educational course, at work, or used to elicit data for research (1). This definition, while somewhat longer, limits tasks to specific actions in a situation. From Littlewood and Doyle, Crookes notes that task is seen as valuable in second language literature and in research into teacher understanding of curriculum which focuses on task. He notes that second language acquisition research on Krashen's input/output hypotheses suggest "the structure and demands of the task with regard to learners' production will also be relevant." and that "A psycholinguistically motivated task characteristic would be one which can be shown to affect the nature of language produced in performing a task in ways which are relevant to second language processing and second language learning." (7). Crookes surveys a large range of studies including Brumfit, Widdowson, Yalden, Allen, Breen, Candlin, Long and Prabhu and concludes there "is insufficient evidence on which to base conclusions as to the efficacy of task-based syllabi." (25).

Crookes then looks at non-second language research in human performance and small group research to inform task sequencing and selection and taxonomies. Crookes supports

Long in wishing to see further research into task within second language for the purpose of understanding "the interaction of task characteristics and language" (32) such that problems of a task syllabus particularly sequence, selection, grouping and ranking could be accomplished. Crookes direction is to create a second language curriculum based on externally researched task classification systems which would leave the learner and teacher out of the design phase except as subjects for psycholinguistic research

Candlin (1987) further expands the notion of task to include aspects of the context in his:

> "working definition of language-learning task: One of a set of differentiated, sequenceable, problem-posing activities involving learners and teachers in some joint selection from a range of varied cognitive and communicative procedures applied to existing and new knowledge in the collective exploration and pursuance of foreseen or emergent goals within a social milieu" (10).

Candlin argues that "task-based language learning is not only a means to enhancing classroom communication and acquisition but also the means to the development of classroom syllabuses." (15). While he recognizes a curriculum level in planning for language learning and teaching he also suggests that "syllabuses emerge as joint plans of the teachers and learners, recording the what, the how and the why." (5). In presenting conditions on task design for language learning, Candlin notes a number of issues which relate to a learner focus in the task-based syllabus. He also notes that the conditions of task design "address some central issues in the contributing disciplines to language teaching and learning: pragmatics, ... second language acquisition; ... classroom management; ... process of communication." (10). Candlin's definition of a language-learning task is somewhat involved but of particular interest here is that it includes input data presented or selected by the learners; roles; settings, classroom arrangements/ groupings; actions or procedures; monitoring; outcomes or goals; feedback or evaluation. In each of these features Candlin leaves room for both the learner and the teacher to participate. "After all, targets for language learning are all too frequently set up externally to learners with little reference to the value of such targets in the general educational development of the learner." (17)

Breen (1987) sets out to provide a descriptive interpretation of alternative syllabus designs and to suggest new directions or syntheses which may emerge. He contrasts a 'conventional' with an 'emergent paradigm' and places task-based syllabi as a 'process plan' within the emergent paradigm. He shows that both task-based and process syllabi incorporate "a broader view of the nature of what is to be achieved in language learning" (164) than do formal or functional syllabi with their emphasis on 'linguistic competence' or 'communicative performance' respectively. This broader view agrees with the approach to task taken here since in a task-based approach "The emphasis is upon using language to communicate and in order to learn" (164). Breen points out that task-based activities are also more relevant to language learners as they focus on "everyday communicative activities" (164). In our case, these everyday activities are firmly anchored in 'everyday' academic, research and writing tasks that will be critical to student success in the mainstream of the school system. Breen also suggests that communicative tasks-based syllabi rely on and assume that "metacommunicating is itself a powerful springboard for language learning" (164).

Long (1989) sets out to write 'against methods', and argues that they are "an irrelevant construct when attempting to influence classroom language teaching. (1) He then proposes that task is a preferred 'unit of analysis' which relates to significant aspects or language teaching as revealed in classroom research and to fundamental understandings of teaching held by teachers. Long claims that "there are six major areas to consider in the design of a successful language teaching program: needs (and means) identification, syllabus, materials, methodology, testing and evaluation. "and that "within syllabus design, as elsewhere, the central issue is choice of the unit of analysis: word, structure, notion, function, topic, situation or task. (5). Long defines language learning tasks as "the things the learners will eventually do in English, at school or university, at work, in a vocational training program, on vacation, an so on - a non-technical, non-linguistic definition. (6). He points out that there is no evidence to support other elements as units of syllabus design or as "meaningful acquisition units" and that tasks "are at least potentially compatible with universal acquisition processes."(7). Long concludes that task-based language teaching can function to link "instructional and learning

strategies in ways consistent with second language acquisition research findings" but that 'careful attention' needs to be paid to the 'use, kinds, properties and combinations of tasks and groups' (20).

These arguments in support of the concept and definition of task and of task-based second language learning are maintained and expanded in a subsequent paper by Long and Crookes (1992). In this paper they present a 'macro' analysis of synthetic and analytic syllabuses and review work done by Wilkins, Nunan, Loschky and Bley-Vroman on syllabus types and conclude that "While it also involves the acquisition of social and cultural knowledge, language learning is a psycholinguistic process, not a linguistic one, yet synthetic syllabuses consistently leave the learner out of the equation" (34). Long and Crookes then distinguish three task-based syllabus types, procedural, process and task, and point out that "all three reject linguistic elements as the unit of analysis and opt instead for some conception of task" (27). They critique Prabhu's procedural plan for not relating pedagogic tasks to target tasks by way of a needs analysis and for the arbitrary sequencing and grading of the tasks. Breen & Candlin's process syllabus is also condemned for no needs identification, for grading and sequencing, for no explicit provision made for a focus on language form and for no clear link to second language acquisition theory.

In contrast, Long and Crookes "adopt task as the unit of analysis in an attempt to provide an integrated, internally coherent approach to all six phases of program design, and one which is compatible with current SLA theory" (43). "It is claimed, rather, that (pedagogic) tasks provide a vehicle for the presentation of appropriate target language samples to learners ... and for the delivery of comprehension and productions opportunities of negotiable difficulty" (43). They further argue that tasks be selected on the basis of 'real-world' targets learners will have to master. While pedagogic tasks in the present study are seen as real in and of themselves, they are communication products and processes valid not only in school contexts but also in the larger digital information world that these students will need to work in.

In a major synthesis of research concerning limited English proficient students (LEP) and the integration of language and content (ILC), Mohan (1991) outlines issues relating to task and second language teaching. He concludes that task-based language teaching (TBLT) "is the most appropriate syllabus model" (135) which relates group work, cooperative learning, learning strategies, English for specific purposes, discourse analysis and knowledge structures. Appropriate to the Marine Mammals unit is Mohan's point that "In programs for LEP students, the target tasks for the integration of language and content include the academic tasks they face in content classrooms ..." (136). Outlining research completed and needed in group and cooperative learning situations, Mohan notes that pedagogical and psycholinguistic arguments for group work offer "a way to evaluate task performance based on known measures backed up by a psycholinguistic rationale" (136) and that cooperative learning research supports the benefits of a non-competitive environment for more natural second language practice. Similarly, "if we are concerned with the integration of language and content, then a central place should be given to the analysis of the discourse of groups of students as they work on target tasks from content ares or learning tasks related to these target tasks (141). Research goals relating to group work or cooperative learning and to discourse analysis also apply here. The application of Mohan's discussion of knowledge structures and the integration of language and content to this research has been reviewed in the previous section.

Nunan (1991) discusses communicative tasks in relation to language curricula and notes that selections of content and teaching processes must connect with "communicative tasks which learners will need to engage in outside the classroom and also with reference to theoretical and empirical insights into those social functions and psycholinguistic processes which facilitate language acquisition" (279). Nunan lists five elements needed to accomplish this goal including "1. An emphasis on learning to communicate through interaction in the target language. 2. The introduction of authentic texts in the learning situation" (279). Both of these suggestions are included in the present study where English is the predominant language of instruction and also of the tasks and the student interactions with them. Certainly the

Internet resources are 'authentic'. Nunan shows that task-based teaching has come to second language education from the education mainstream and that task-based language teaching "has been supported by changing conceptions of the nature of language and learning - captured under the rubric of communicative language teaching" (293).

Summary

Literature on task-based language teaching and learning shows that there is collective agreement on the viability of task as a unit of analysis and syllabus development and on the value of communicative-task activities as a suitable base to activate language learning. There is divergence of opinion on the defined size, scope and syllabus structure for task as well as on the kinds of tasks most suitable for second language learning. However, the research generally is supportive of the notions of task adopted within the Marine Mammals unit: that research and teaching practice can integrate knowledge structures and task; that tasks are a fundamental unit of analysis applicable to both content and language learning objectives; that discourse analysis may provide a window on task and students' academic language development; that tasks match closely with teachers' conceptions of instruction and thus offer the possibility of making research accessible to the improvement of instruction.

C. Computers in English Second Language Education

Introduction

The field of computer-assisted language learning (CALL) was surveyed as part of the process of placing this thesis in context. The survey looked for overview research and also for particular research projects which investigated work with ESL students and computers in situations where the computer served multiple functions as an information resource and as a tool and tutor for researching, writing and presenting. Initial search descriptors identified many articles which focussed on one these functions but none which examined student learning in a comparable environment. Papers tended to be narrowly concerned with topics such as: using surface features of a word processor for transcribing, formatting and revising student essays; completing computer exercises on discrete language features through computer drills; or on using databases and multiple media resources to provide context for target

language practise. An understanding of the lack of comparable research papers can be had by examining the recent history of CALL research and also by examining general trends in educational technology research.

History of CALL Research

Mark Warschauer (1996) provides an overview of three phases in the history of computer -assisted language learning. His phases correspond with general developments in information technology and its application in educational settings over the past thirty years as well as with changes in approaches to teaching English as a second language. He defines Behavioristic CALL (1960's & 1970's), Communicative CALL (1970's & 1980's) and Integrative CALL (1980's & 1990's). He notes that the phases are not discrete and that the way in which the software is used does not necessarily correspond to its definition. Behavioristic CALL "entailed repetitive language drills and can be referred to as 'drill and practice' (or, more perjoratively, as 'drill and kill')" (1996, 3). Communicative CALL moved toward more authentic communication using the computer for more interactive skill practice, for language stimulus or for language work. During this phase researchers such as Dunkel (1990) and Roblyer (1988) were interested in meta-results of investigations into the question of the effectiveness of computer treatments on student achievement and attitudes. CALL research results paralleled research results in the broader area of computers in education and tended to identify modest positive impacts from the application of computer technology on both the subject and the student. Research at this time also began to identify other impacts related to changes in the classroom environment and the promotion of student collaboration and cooperation (eg. Johnson, 1990).

Two papers which looked closely at the use of word processing in ESL classes can stand as examples of the type of research conducted and of the results reported during this phase. Cardenas (1990) and Herrmann (1985) discuss situations in which the computer is used as a single purpose tool within a process writing environment. In both situations students were encouraged to learn to use the word processor to record and edit drafts of assignments which were part of the general curriculum. Both researchers argue that the word processing

environment is beneficial to ESL students for many of the reasons commonly found in the word processing literature generally. That is, word processing facilitates revision, is motivating and engaging, promotes greater language awareness and encourages the use of the target language. These papers focussed on a communicative application of computers in ESL and writing as they employed the computer in a process writing environment and in teaching language in the context of other learning.

Warschauer's final, Integrative phase is subdivided into Multimedia and Internet sections and labeled "Steps toward" (1996:6) indicating that it is not yet well established in teaching practice. He defines this phase as a response to "educators seeking ways to teach in a more integrative manner, for example using task- or project-based approaches" (1996:6) and as an approach seeking to "integrate the various aspects of the language learning process" (1996:6). In defining hypermedia environments, Warschauer identifies four main features: authentic learning environment; integrated skills environment (reading, writing, speaking and listening); student control of their progress in the environment; and, "a principle focus on the content, without sacrificing a secondary focus on language form or learning strategies" (1996:6). The ideas of a task/project approach, of authentic assessment, of a dual focus on content and language and of integrated skills development correspond to key features of the computer-centred learning environment developed for the Marine Mammals unit of study.

Also in the discussion of multimedia and hypermedia, Warschauer notes two problems accounting for the small impact of these programs on CALL: limited availability and limited interactivity. He states that "While teachers themselves can conceivably develop their own multimedia programs using authoring software such as HyperCard (for the Macintosh) or Toolbook (for the PC), the fact is that most classroom teachers lack the training or the time to make even simple programs ..." (1996:7). Regarding the issue of artificial intelligence Warschauer refers to the hypothetical framework outlined by John Underwood in "On the Edge: Intelligent CALL in the 1990's" (1989).

Underwood's position and also that of Carol Chapelle in "Using Intelligent Computer-Assisted Language Learning." (1989) are based on anticipated progress in artificial intelligence

and natural language processing. In these articles, Underwood and Chapelle describe current and future products which meet their criteria of intelligence. Chapelle explains how these systems could support students through the prewriting, drafting and editing phases of the writing process with intelligent tutoring in the form of guidance, examples and remediation. Underwood discusses some examples of high tech projects where the computer is both a communications tool and a tutor for the student. However, the kinds of functional or communicative competencies which they describe focus on using simple oral language correctly within the context of the computer mediated environment. This emphasis on computer-assisted language instruction (CALI), as described by Chapelle and Underwood does not address the need for academic language and content support of the large range of ESL learners in schools. The kinds of intelligent software and hardware they describe have the potential to be used more broadly to support further levels of language learning.

A paper by James Strickland, "Evaluating Computer-Tutors: A Protocol Study" (1987), describes a process writing environment in which the computer had both tool and tutorial features. The research represents a single-media model of the kind of intelligent tutoring system that Chapelle and Underwood imagine. Interestingly, Strickland observes that, while the computer-based tutoring process had a measurable positive effect on the quality of the subject's writing, the subject seemed unaware of these benefits and did not use other help features of the word processing program to extend the tutoring process. Strickland concludes that tutoring protocols would be most effective if developed and activated at the editing stage of the writing process.

Warschauer concludes that "Multimedia technology as it currently exists thus only partially contributes to integrative CALL" as it seldom combines "meaningful and authentic communication into all aspects of the language learning curriculum" (1996:8). Warschauer then points to the Internet as a both an information resource and as a forum for authentic communication. He cites two examples where ESL students "benefit from a high-tech/low-tech combination to implement an integrated skills approach in which a variety of language skills are practiced at the same time with the goal of fostering communicative competence"

(1996:9). In both examples students use the computer and the Internet as a writing tool to research, write and revise their work in electronic collaboration with the teacher and English first language mentors. The focus is on text but Warschauer predicts that this focus will change as other media become more commonly communicated over the Internet. Warschauer's explanation of the limited number of project examples helps explain the absence of research examples matched to his integrative definition and to the kind of computer environment studied in this project.

Changing Paradigms in Educational Technology Research

Looking beyond the field of computer-assisted language learning reveals some useful insights into the implications of information technology use in education generally. In recent articles, Roblyer (1996.a & b) places her earlier work on the impact of computer-based instruction in a new context. Roblyer argues that the basis for educational research is changing. By tracing technology research from the 1970's through the 1990's Roblyer shows that the debate has moved from questions about whether technology has a positive influence on educational outcomes to questions about the nature of educational research in general. As a result of this debate, the kinds of research questions being asked about instructional technology are also changing. Roblyer notes that "the focus has shifted dramatically away from the possible impact of a technology product or method to how technology can help teachers change key aspects of the teaching and learning environment" (1996.b:12). Roblyer further suggests that this change is a response to criticisms of educational research methods and to "an ongoing controversy some have called the constructivist/objectivist debate" (1996.b:12). Within constructivist practice she identifies six key characteristics: problem-oriented learning activities; visual formats; rich learning environments; collaborative and cooperative group work; learning through exploration; and authentic, qualitative student assessment methods (1996.b:13). These characteristics relate to many aspects of the current research project and also to the ten year summary findings of the Apple Classrooms of Tomorrow (ACOT) research project (1995).

The ACOT research report title, "Changing the Conversation About Teaching, Learning & Technology" anticipates Roblyer's point of view that research into the influence of computers on education requires different questions than those originally asked. In the introduction to the ACOT report, David Dwyer makes the point of a changing focus clear, "We'd like to use what we've learned in ACOT to change the conversation about technology and education. Instead of talking about computers, for example, we talk about learning" (1995:7). Some of the major themes about how people use technology for teaching and learning outlined in the ACOT report indicate positive affects in these areas: encouraging and supporting student collaboration; increasing forms of communication and supporting multiple representations of ideas (1995:20-21). The ACOT report also concludes that "We know that students and teachers are developing new competencies, many of which are not measured by current tests" (1995:21).

While the research literature does not provide specific and equivalent examples of research studies it does indicate that a number of features of this project overlap with current trends in both educational research and educational applications of information technology. Specifically, this research looked at students working in a a collaborative environment, using computers as a tool, tutor and forum for research, writing and presenting.

CHAPTER 2: DESCRIPTION OF THE MARINE MAMMALS UNIT

A. Development of the Unit

The Marine Mammals unit of study began with the ESL classroom teacher's request for collaborative support from the teacher/librarian in co-planning a research unit for a group of second year, reception-level students. Before requesting a meeting, the teacher had reviewed the Intermediate Science curriculum goals and selected a topic and main objectives for the students. The general outline of the unit included an introduction to Canadian marine mammals and their environments. Content goals for students included discovering basic facts about the animal such as appearance (size, weight, body covering, body parts), classification (which sub-group of mammal), and adaptations to a marine environment (diet, social behaviour, movement, breathing, thermoregulation). These content goals were to be linked to a classroom study on pollution and ecosystems and further linked to a library study to build vocabulary and background knowledge about animal classification, food chains, habitats and ecosystems. Concept goals included an awareness of animal adaptations to an environment, the effects of humans on that environment and the consequences for the animal's well being.

To develop the computer representation of these goals the researcher was invited to create a draft set of computer activities and to review Internet resources which might provide information for students to access. The teacher/librarian, classroom teacher and researcher had worked together in previous years to develop similar units of study linking language development and library research topics with computer resources, computer skill development and computer presentations. The inclusion of the Internet was a new feature to extend the use of the computer as an information resource. Student learning objectives related to the use of the computer were based on past computer projects and focussed on integrating computer skill development with curriculum learning. Students were expected to develop and improve their computer skills while learning the academic content of the unit. Computer skills were thus an integral part of the project and were not taught in isolation. The role of technology and the form of the computer activities were based on the accumulated experience

of the researcher and teachers involved. Over the course of earlier collaborations they had observed that minimally structured researching, reading, notetaking and writing tasks commonly assigned to intermediate regular grade students were generally unsuccessful for the school's ESL students. Open ended tasks with implicit performance expectations were often confusing for the ESL students and did little to develop content understanding or language skills.

In this first year process of introducing the school to the Internet the researcher had also observed successes and frustrations encountered by other classes and teachers which further informed the format of the tasks created for this research project. In particular, through a lack of familiarity with the nature of information resources on the Net, teachers were often disappointed to discover that after spending many periods 'surfing the Net' students had only used low-level browsing skills, had not employed any higher level information processing skills and were unable or unprepared to show much learning growth. These observations led to the design of a digital environment to integrate Internet researching, recording, reflecting and presenting.

In the fall of the school year all three teachers met to review a draft of the computer tasks and of the Internet resources. After reviewing possible Internet resource sites it was agreed that the Marine Mammals topic and goals were suitable for an Internet research project. Objectives for the computer tasks also emerged during the collaboration and included basic skill development in operating system and Internet navigation, as well as wordprocessing and graphic tool use related to recording and presenting information.

Based on the experience of the teachers involved, the computer design incorporated language learning goals focussed on reading and writing. One concern was to find ways to support ESL students in reading and understanding the Internet resource pages particularly as these pages were written for a general audience and varied greatly in organization, content and language level. A second concern was to support the students in notetaking and later in writing sentences and paragraphs from the notes. To help focus the reading task, the major Internet resource pages were surveyed for similarities in content and organization. These

similarities were compared to the curriculum goals set out by the classroom teacher and helped to determine the research task categories and vocabulary which were included in the project's Marine Mammals homepage and the students' HyperCard workspace. The goal was to have students start from and work within pages that mirrored the likely content of the resource pages and which guided them towards identifying and reading the target information. The recording task was similarly designed to mirror the content categories and key information with instructions, prompts and templates included in the Notebook field of the HyperCard stack. The HyperCard stack also included a graphic task designed to help students think about the information they had read and recorded by representing the information in a visual format. The key visual work could be simultaneous or subsequent to the notetaking but prior to the writing step and was intended to refine and reinforce their understanding of the content as well as to provide a guide for writing.

Implicit in this overall task design were concepts about helping students read and understand new content by first having them approach, deconstruct and record the information in an organized way and second by having them reconstruct this knowledge graphically and in writing. Development of student language skills appropriate to the content was thus an overarching goal of the unit and was based on the experience of the teachers in using the Vancouver School Board's Framework for Teaching and Learning (1987) as a model for academic-cognitive language development. Applying the model to student work in a digital and Internet environment was a novel part of the project goals.

When the draft Internet and HyperCard tasks were completed the teaching plan was finalized. It was decided that the first set of student task cards on the Beluga Whale would be completed by all students in the group. Work on these introductory tasks would review the students' HyperCard skills and introduce them to the Internet and to the Internet browser software, Netscape Navigator. Students would also learn the process of moving between the Internet window and their work space window and would become familiar with the design and general expectations of the unit tasks.

The first set of task cards, Beluga Stack (Appendix 1), was then completed by the researcher. This stack took advantage of HyperCard's simple multi-media authoring features to allow students to navigate between cards and to present spaces for guiding student notetaking, drawing and developing key visuals and finally, for their writing. Navigation and access to the notetaking window was accomplished by a set of five small buttons located in the top right corner of the HyperCard window. Arrow buttons moved the students forward or backward through the stack. A Notebook button opened a small wordprocessing window which contained research and notetaking instructions about information to seek on the Internet page and drawing instructions for completing the card graphic. All cards in the Beluga Stack contained a graphic template for the students to complete according to the information they discovered. Two additional buttons were included in the stack to facilitate navigation and to be available for use in the final presentation stack. The working copy of this stack included twelve cards: one menu card, eleven task cards and one quiz card. The HyperCard stack was then transposed into a set of World Wide Web pages containing links to selected Internet resources. This transformation insured that the Internet pages the students began from mirrored the assignment and guided them to the main resources. These pages were uploaded to the school board's server to be available to the students whenever they were working in the Internet lab.

In the preliminary lessons in the Internet computer lab, the students learned to open the browser, navigate to the Beluga pages and open their HyperCard work space. Once they had both the Internet and the HyperCard windows open they were able to follow the on-screen instructions to locate information on the Internet and to record it into their Notebook window either by typing, or by copying and pasting. Student success in using the stack was observed variously by the teacher/librarian, researcher, computer support teacher and classroom teacher all of whom contributed suggestions for modifying the Beluga Stack to create a generic stack which would be applied to other marine mammals. All students in the research group worked on the Beluga whale stack, usually working on the same or adjacent task cards. Students worked in pairs on the second marine mammal they studied.

When completed by the researcher, the draft of the generic stack was reviewed by the teacher/librarian and classroom teacher and final suggestions were made for reducing the total number of task cards and for combining the notetaking guide with language supports specific to each card. The final stack, Marine Mammals (Appendix 2), consisted of eight cards: a menu, six task cards and a quiz card. Student instructions for notetaking, graphics and writing were included in the Notebook (Appendices 1& 2). These instructions also served as teachers' guides for the teacher/librarian, classroom teacher and computer support teacher when they were instructing and supervising the students. The researcher's role became strictly that of an observer and technical problem-solver should there be technical difficulties with the computer hardware or software.

Internet access for the generic Marine Mammal tasks also became more general and consequently more challenging for the students. In the Beluga activities, Internet links were matched to each task card to help students become familiar with both the Internet and with their tasks. For the research on additional marine mammals, appropriate Internet sites were identified by the researcher and teacher/librarian, collected onto a single indexing page and mounted on the server. This Marine Mammals web page (Appendix 3) was the student's main starting point for gathering Internet based information but the task now required students to review the resource pages, identify pertinent information and record that on the appropriate task card. This challenge was in keeping with the teaching goal of supporting ESL students in developing their general academic research skills as well as their language skills. (Figure A3.7 - Student's Digital Environment shows an example of the open windows which comprised the students' computer environment).

Library Activities

Before beginning the computer and Internet part of the unit the students worked with the teacher/librarian for twenty-four lessons over the course of approximately four months or twelve weeks. During these lessons the students studied the following topics and completed the listed activities.

Table 2.1 - Marine Mammals Library Unit Activities

TOPIC	SUB-TOPIC	ACTIVITY
A. Animal Families (Classes)		Chart (web)
	Mammals	Notetaking/Sentence writing
B. Marine Life		Chart (classification tree)
	Seaweeds	Notetaking/Sentence writing
	Fish	Notetaking/Sentence writing
	Mollusks	Notetaking/Sentence writing
	Crustaceans	Notetaking/Sentence writing
	Echinoderms	Notetaking/Sentence writing
	Plankton	Notetaking/Sentence writing
C. Marine Food Pyramid		Chart (pyramid)
D. Glossary		ongoing compilation
F. Amos and Boris	by William Steig	story
G.Quiz		

During this part of the unit the teacher/librarian's tasks were to: locate resources which described the topic for each lesson ; introduce the topic to the students; guide group notetaking sessions; guide group sentence writing; check student written work. The notetaking tasks introduced students to the process of recording short, meaningful notes and reconstructing the notes into sentences. Each topic usually took two, forty minute lessons to complete. In developing this part of the unit, the teacher/librarian set a number of goals which combined the following library and classroom, research skill and content learning objectives: to provide the students with a greater appreciation and understanding of marine life; to provide an understanding of terms which would be encountered in student Internet research by creating a glossary; to develop an understanding of how non-fiction books are organized in the library; to develop skills in notetaking, in reading and making charts, and, in writing.

Student tasks in the library expected students to learn to: search for information in provided references; go to the library shelves to locate books on the topic; share information about the topic orally, and through pictures; participate in group notetaking sessions which focused on key words and ideas; sequence notes through group discussion; convert notes into sentences, again as a whole group task.

The library part of the Marine Mammals was not a formal part of the research project although the researcher observed student work in the library and considered the topics covered and skills developed when designing the Internet and computer notetaking environments. An important difference between the library and the computer labs was the high degree of independent, pair or individual work undertaken in the labs. In the library, the students typically worked together as a whole group and were able to complete tasks collectively. Of particular interest to this group of ESL students was the ability to get the 'right' answer and complete all parts of a task. In the Internet and computer lab environment not only were students expected to be more independent, but the 'right' answers were less available, partly because the work was more challenging and partly because the Internet resources often provided contradictory information. The students' traditional school work experience led them to expect to complete all parts of an assignment. This expectation did not match either the card tasks, which were open-ended, nor the Internet resources, both of which had more options than the students were used to. Consequently, they had to learn to select the most important information for each animal and card which would be 'enough' to complete the task. In each of these ways, the Internet research part of the Marine Mammals unit extended and challenged the students' skills beyond the level necessary for success in the library portion of the study.

In reviewing the library part of the unit, the teacher/librarian made the following observations, first about the content part of the unit: "Generally, I would say the students accomplished the tasks set before them, and have a greater appreciation of and understanding of marine life." Regarding the students' research skill development: "Learning the skills outlined above was the most challenging aspect of the library unit. The students worked diligently, and all achieved at least a satisfactory level of success. In working together as a group, the more capable students provided leadership in the notetaking and sentence writing activities" (personal communication, 13 June 1997).

Non-Internet Computer Lab Activities

During the Marine Mammals phase of the research project the students were also able to use the regular Macintosh computer lab to continue HyperCard graphic and writing tasks that they had not finished in the Internet lab. This additional work time was supervised by the teacher/librarian and classroom teacher who were available to answer questions. Part of this time was used by the researcher to review HyperCard graphic tools and techniques to allow the students to do more detailed work on their graphics. During the last week of school this additional lab time allowed some students to complete parts of the HyperCard stacks in preparation for printing the hard copies to be bound into booklets.

B. Setting

The research setting was a large, inner-city elementary school. The historic, multicultural neighbourhood had a mixed socioeconomic population and had a long history of changing immigrant populations. Both the school and neighbourhood populations were predominantly of Asian heritage with Chinese as the main first language group. While approximately eighty percent of the school population were not native speakers of English the majority of the students were Canadian born. The ESL nature of the social setting was important since the students were working in a community, school and public library setting where many languages, other than English, were commonly used. Unlike students in many other North American schools and communities, these ESL students were not in an English-immersion setting. For them, the need to develop social and academic language skills in English was not so pressing as it would be in other settings as there is considerable support and opportunity for them to maintain their first language. Nevertheless, school instruction expectations and production were predominantly in English, although student talk was often in a first language.

Within the school, research was conducted in the library and in two computer labs. In the Library, students worked with the teacher/librarian to learn vocabulary and background concepts associated with the Marine Mammals unit. Library work was usually small or whole group work with the students working to complete tasks introduced to the whole group by

the teacher/librarian. Library research groups worked around small tables, usually one group per table. Instruction in the library often began with the large group in front of a small blackboard and continued at the tables with individuals or small groups. Key tasks in the library were researching, sharing information orally as well as group notetaking, sequencing and sentence writing.

In the computer labs, the students worked with either the teacher/librarian, the computer support teacher or the classroom teacher to complete different parts of the HyperCard stack. Internet lab periods were twice a week for forty minutes and the focus was usually on accessing the net and recording information in the Notebook for later review and writing. Regular computer lab periods were once a week for eighty minutes with about half of the time given to the students to complete graphic tasks and to continue writing from the Notebook and graphic to create their 'good' sentences and paragraphs.

In both settings, students were free to move about and to view and discuss their work with others or with the teachers. In the computer environments, this often led to changes and additions to the group's work as interesting ideas or methods discovered or requested by one student or group were shared with others. The researcher was available during these sessions to observe and record student work, student to student interactions and teacher instruction.

C. Student Biographical Data

All of the students in the group were in their first or second year in a sheltered ESL class. Most were preparing for full integration into the regular classroom stream for the following year and the Marine Mammals unit was one of the final projects designed to help them with the basic research and writing skills needed for success in mainstream intermediate grade classes.

The following tables summarize the basic information for each child. The Student Profile was compiled by the classroom teacher and the Student Data was drawn from school and school board registration records.

Table 2.2 - Student Biographical Data & Profiles

ALLAN	STUDENT DATA	STUDENT PROFILE
Name	Allan	- at grade level in Chinese language
Sex	M	- good marks in other academic subjects in
Birthdate	1/4/87	Chinese school
Age (years.months)	10.3	- high academic ability, Gr. 5 program but Gr. 4
Entry into Canada	7/11/96	age, Math = B
Time in Canada	0.8	- had English basics in Hong Kong but little
Previous Cdn. sch,	0 Cdn schools	speaking ability on arrival
Birthplace	Hong Kong	- active and conscientious student
L1 & Home Lang.	Cantonese	- only child
Partner/Research	Helen	- topic Killer Whale

DAVID	STUDENT DATA	STUDENT PROFILE
Name	David	- repeated Gr. 1 in China
Sex	M	- weak Chinese language skills
Birthdate	7/8/85	- weak Math skills
Age (years.months)	11.9	- no English in China
Entry into Canada	8/3/94	- low academic ability, particularly in Reading
Time in Canada	2.8	and Spelling, Math = C-
Previous Cdn. sch,	3	- tries hard
Birthplace	China	- youngest of 4, 2 older brothers, 1 older sister
L1 & Home Lang.	Cantonese	- Grey Whale
Partner/Research	Richard	

HARRY	STUDENT DATA	STUDENT PROFILE
Name	Harry	- below grade level in Chinese language
Sex	M	- average marks in other subjects in Chinese
Birthdate	4/26/85	school
Age (years.months)	11.11	- low academic ability, weak in Reading and
Entry into Canada	10/9/94	copying, Math = C
Time in Canada	2.6	- no English in China
Previous Cdn. sch,	2	- lacks effort and can be a behaviour problem
Birthplace	China	- youngest of 8 children
L1 & Home Lang.	Cantonese	- Polar Bear
Partner/Research	James	

HELEN	STUDENT DATA	STUDENT PROFILE
Name	Helen	at grade level in Chinese language
Sex	F	- good marks in other academic subjects from
Birthdate	7/7/86	Chinese school
Age (years.months)	10.9	- high academic ability, Math = A
Entry into Canada	4/9/95	- had English in Hong Kong but little speaking
Time in Canada	2.0	ability when registered
Previous Cdn. sch,	0 Cdn schools	- has piano (Gr. 3 or 4), very artistic
Birthplace	Hong Kong	- 1 younger brother
L1 & Home Lang.	Cantonese	- hardworking and studious
Partner/Research	Allan	- Killer Whale

JAMES	STUDENT DATA	STUDENT PROFILE
Name	James	- at grade level in Chinese
Sex	M	- excellent marks in Chinese school in academic
Birthdate	3/21/84	subjects
Age (years.months)	13	- had basic English in Hong Kong but little
Entry into Canada	6/30/96	spoken English when he first enrolled
Time in Canada	0.9	- high academic ability, Math = A, recommended
Previous Cdn. sch,	0	for enriched Gr. 8 Math
Birthplace	Hong Kong	- artistic, intelligent, hard working/studious
L1 & Home Lang.	Cantonese	- 1 younger brother
Partner/Research	Harry	- Polar Bear

LARRY	STUDENT DATA	STUDENT PROFILE
Name	Larry	- completed Gr. 3 in Philippines
Sex	M	- average academic ability, most capable of
Birthdate	1/20/85	brothers, can sight read fluently, remedial Math
Age (years.months)	12.2	(Gr. 2/3 level), LAC support
Entry into Canada	5/15/95	- no English when registered at Strathcona
Time in Canada	1.11	- 2 twin brothers, father died in Philippines
Previous Cdn. sch,	0 Cdn schools	- athletic
Birthplace	Philippines	
L1 & Home Lang.	Ilocano	
Partner/Research	none	- only worked on Beluga part of project

MICHAEL	STUDENT DATA	STUDENT PROFILE
Name	Michael	- no schooling in Viet Nam (left country when 4
Sex	M	years old)
Birthdate	6/25/84	- 3 years in refugee camp in Hong Kong
Age (years.months)	12.9	- 2 years in refugee camp in Philippines
Entry into Canada	12/14/94	- average academic ability, at Gr. 5 level but Gr. 7
Time in Canada	2.4	age, Math = C, verbal child
Previous Cdn. sch,	1 Cdn school	- tries his best but often gets muddled and
Birthplace	Viet Nam	confused, lacks organization and study skills
L1 & Home Lang.	Cantonese	- 4 children in family, 2 older brothers, 1 younger sister
		- Narwhal
Partner/Research	Robert	

MILLIE	STUDENT DATA	STUDENT PROFILE
Name	Millie	- at grade level in Chinese language
Sex	F	- good marks in academic subjects in Chinese
Birthdate	5/12/85	school
Age (years.months)	11.11	- better than average academic ability, Math = B
Entry into Canada	10/14/95	- no English in China
Time in Canada	1.6	- hardworking and studious
Previous Cdn. sch,	1 Cdn. school	- 1 younger sister
Birthplace	China	
L1 & Home Lang.	Cantonese	- Sea Lion
Partner/Research	Suzy	

RICHARD	STUDENT DATA	STUDENT PROFILE
Name	Richard	- completed Gr. 3 in Philippines
Sex	M	- low academic ability, weak in Reading and
Birthdate	12/1/85	Writing, remedial Math (Gr. 2/3 level) and
Age (years.months)	11.4	receives LAC support
Entry into Canada	5/15/95	- no English when registered at Strathcona
Time in Canada	1.11	- 1 older brother, and 1 twin brother
Previous Cdn. sch,	0 Cdn schools	- athletic
Birthplace	Philippines	
L1 & Home Lang.	Ilocano	
Partner/Research	David	- Grey Whale

ROBERT	STUDENT DATA	STUDENT PROFILE
Name	Robert	- repeated Gr. 2 in Philippines, learning
Sex	M	difficulties in Filipino school
Birthdate	12/1/85	- low functioning, weak in Reading and Writing,
Age (years.months)	11.4	receives LAC support in Language and Math (Gr
Entry into Canada	5/15/95	2/3 level)
Time in Canada	1.11	- no English when registered at Strathcona
Previous Cdn. sch,	0 Cdn schools	- 1 older brother and 1 twin brother, father died
Birthplace	Philippines	in Philippines
L1 & Home Lang.	Ilocano	- athletic
Partner/Research	Michael	- Narwhal

SUZY	STUDENT DATA	STUDENT PROFILE
Name	Suzy	- no schooling in Vietnam, left country when a
Sex	F	baby
Birthdate	4/23/86	- 5 years in refugee camp in Hong Kong
Age (years.months)	10.11	- 1 year in refugee camp in Philippines
Entry into Canada	7/26/94	- average academic ability, Math = C, weak in
Time in Canada	2.9	Reading and Writing
Previous Cdn. sch,	1 Cdn school	- 4 children in family, 1 older sister, 1 younger
Birthplace	Viet Nam	brother and baby sister
L1 & Home Lang.	Vietnamese	- conscientious and tries her best
Partner/Research	Millie	- Sea Lion

D. Narwhals Stack by Michael

The following cards were completed by Michael, a Grade 7 age student born in Viet Nam, who had had been in Canada for two years and four months. Prior to coming to Canada, he had spent five years in refugee camps in Hong Kong and the Philippines. This was his first Canadian school and his second year in the ESL class. The classroom teacher felt that he was of average academic ability and described him as a 'verbal child' who 'tries his best but often gets muddled and confused, lacks organization and study skills'. His teacher-selected partner for the second animal research was Robert. Robert was born in the Philippines, spoke a different first language, was in his first year in Canada and was considered a 'low

functioning' student by the classroom teacher. The partnership appeared to work well with both boys cooperating to locate and record Internet information. Although the similarity of their notes and graphics shows this cooperation, their sentences are different in order and structure. This difference was not imposed by the teachers but reflects the students' preference and willingness to use the resources to write their own sentences.. Some partnerships showed more similarity in their sentences but identical work was not common. This suggests that the tasks were flexible and adaptable to different student needs, abilities and uses.

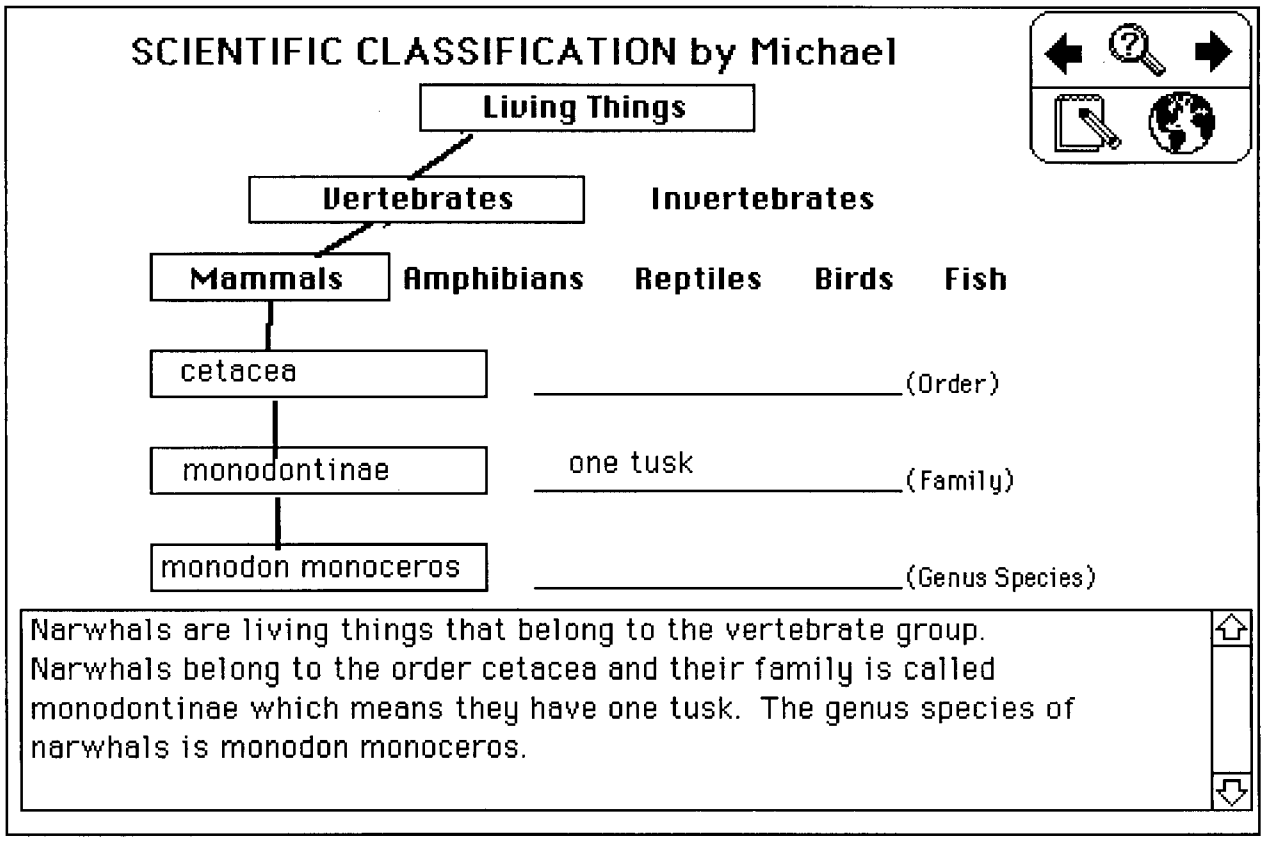
The following figures are a complete record of Michael's work on the second part of the Marine Mammals project in which he and Robert researched Narwhals. In the Notebook section, the teachers' Notes, Words and Drawing Instructions have been excluded while Michael's additions to the Notebook have been underlined. In the Card Graphic & Sentences section, the presentation layer of the card is shown exactly as Michael completed it. The Comments section includes the researcher's observations about Michael's notes, graphics and sentences.

Classification Card:

Notebook

- Order =cetacea
- Family = cetacea= the narwhal famcetaceamonodon monoceros monodontinae

Figure 2.1 - Classification Card



To complete this language and content learning task to the point shown in Figure 2.1, Michael needed to work through a number of challenging steps. First, he had to read and follow the Notebook and Internet instructions and prompts to locate and view the resource pages for the Narwhal. Second, he had to work with his partner to read these pages and identify the key pieces of information to record. Third, these information bits needed to be moved from the Internet into the Notebook on the appropriate HyperCard topic page.

Fourth, the information had to be represented on the key visual. Finally, Michael had to write sentences interpreting and reconstructing the information about the Narwhal he had recorded on the graphic and in the Notebook. Each of these steps worked towards a final goal of having a complete and presentable card and each step required Michael to make practical and real use of his English language skills. The key visual and notetaking tasks were designed to link the knowledge structure of classification to both the content material of the Internet resources and to the final writing task. The key visual is a classification tree and the Notebook prompts followed the same order.

Michael appears to have had some difficulty pasting notes into the Notebook as part of the notes overlap and have overwritten the 'genus species' prompt. His partner's notes are complete and it is likely that Michael used Robert's notes to help him get the scientific words in the correct order. On this card, the graphic task was a relatively straightforward one of matching information to the the correct level of the tree, some cards required more complicated re-working of the data and also the copying of an image from the Net. Michael has clearly attended to the graphic task since all the words are correctly spelled and are neatly contained within the frames and lines he added to the visual. Unlike his partner and many of the other students, Michael has not taken extra time to include 'fancy' fonts or add embellishments to the lines and frames but the classification tree is nevertheless clear and correct. The lines intended to display the meanings of the Latin terms are incomplete as few students were able to find explanations for the scientific names of the animals since most of the Internet resources included, but left undefined, the Latin words. Since the explanations had been given on the beluga whale pages some of the students found this gap frustrating and they examined a number of Internet resources in search of the answers. Michael and Robert were one of the few pairs able to find an explanation, in this case, for 'monodontinae', and they recorded this on the graphic and included it in a sentence.

The contrast between Michael's first two sentences and the final one highlights a problem common to much elementary student research and writing, ensuring that writing is

matched to comprehension. This contrast also illustrates strengths and weaknesses in the writing process established in this project.

Michael's first two sentences successfully convey meaning and show how the task design can link Notebook and Graphic to help the students write comprehensible and sophisticated sentences. In the first sentence, "Narwhals are living things that belong to the vertebrate group", Michael has written directly from the graphic and included 'belong to' from the Notebook's word bank. In the second sentence, by combining and extending two levels of the classification tree with 'belong to' and 'means', Michael has created a complex rather than a simple sentence. Students were already familiar with writing simple statements and one of the goals of the project was to provide supports to help them write more sophisticated sentences. Michael's second sentence is an example of how students could use the graphic to establish the order of sentences and the word bank to combine simple sentences with a subordinate clause to create a more sophisticated sentence.

The final sentence, "The genus species of narwhals is monodon monoceros.", is correct but it is likely that it conveys little meaning to the writer or to most readers. In this example of reconstructing text from notes and graphics it is apparent that the missing information regarding the meaning of the Latin words did not deter Michael from writing based on the words he had available to him. He was able to compose the sentence since he had correctly matched 'monodon monoceros' to the 'genus species' line on the tree. Unfortunately, the missing meanings for this and the 'order' line thwarted the design intent of the graphic which was planned to show students the progression of meanings down the classification tree. Thus, the goal of having students write about what they had learned was not achieved in this sentence.

Size Card:

Notebook

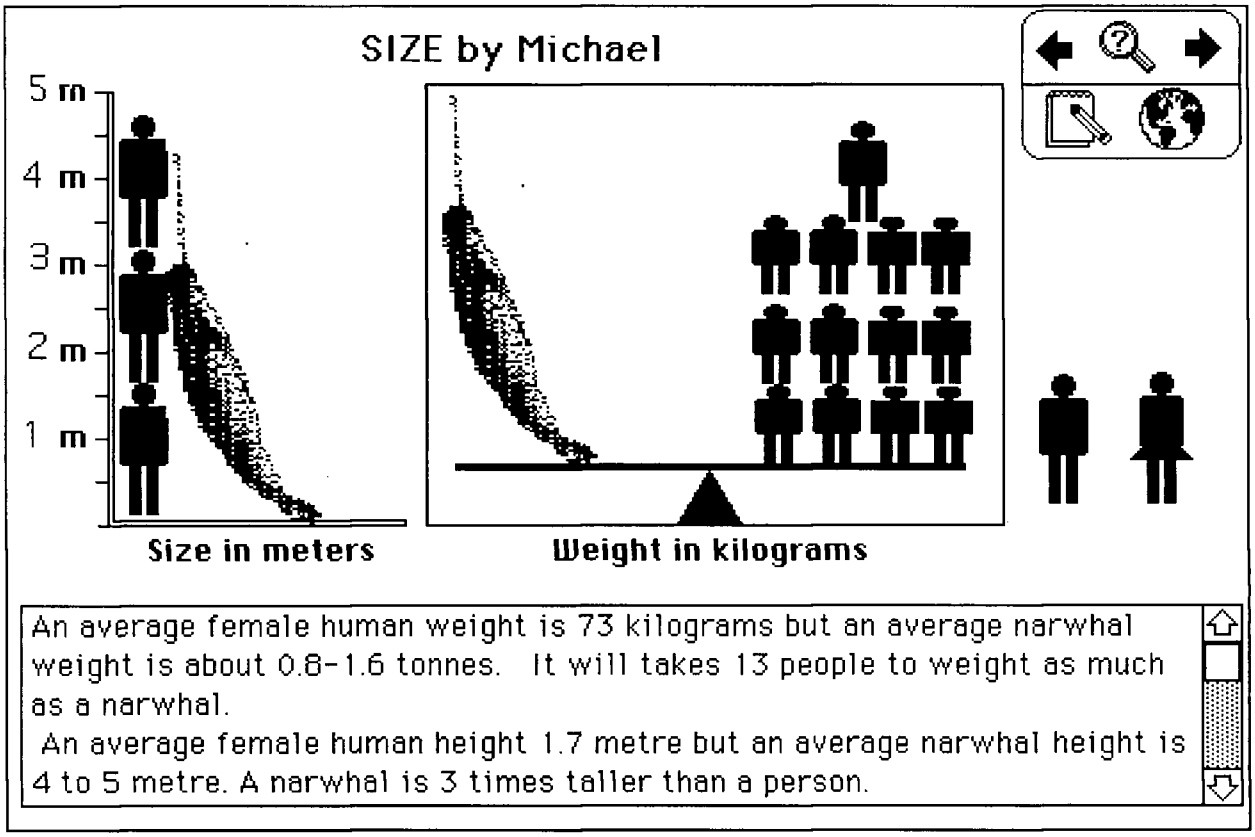
Animal:

- Average male length or height = An adult Narwhal will grow to a length of 4-5m (13-16ft)
- Average male weight =

Human:

Average male human height = 1.7 m; weight = 73 kg
Average female human height = 1.6 m; weight = 61 kg

Figure 2.2 - Size Card



For the Size card, the Notebook and key visual tasks were based on the knowledge structure of comparative description. The students' recording and interpreting tasks selected two size descriptors, height and weight which were common in all of the Internet resources, and organized the writing task around the visual representation of the comparison between human and animal sizes.

Although Michael did not complete all of the Notebook lines, he included the missing weight information in his sentences. He presumably worked with Robert to collect and use the data to calculate the number of human figures needed to balance the scale. There is an unusual contradiction between male and female data in Michael's sentences and graphic. His partner, Robert, has recorded, drawn and written about female beluga and human weights but Michael has drawn male figures and used male numbers in sentences with the word female. This is an example of a situation in which the graphic could provide an easy opportunity for a teacher to point out a contradiction to a student and to find out whether it is a misunderstanding or an accident. With a longer timeline these anomalies would likely have been noticed in the proofreading process when students would read their sentences to either the teacher or another student. This confusion of male and female originates from the goal of having students work with the information available on the Internet rather than with texts written especially for students. It was common for the Internet resources to distinguish between male and female data and therefore it was necessary for the task design to try and alert students to notice and attend to this difference. Students also needed to observe the difference between metric and Imperial units of measurement. In most cases, the students managed to separate male and female, metric and Imperial data and even when there was confusion it seldom detracted from the overall quality of their graphic or written work.

Michael's first paragraph used both the Notebook and graphic to compare human and narwhal weight. His first sentence used Notebook information and 'but' to contrast narwhal and human weight. 'But' was not included in the word bank on this card although it had been the focus of an earlier lesson on writing sentences contrasting human and beluga adaptations. Michael used 'but' in two sentences on that beluga card and appears to have become confident in its use as he used 'but' twice on this Size card and once on the subsequent Appearance card.

The scale visual was popular with the students who seemed to enjoy working out the numbers and then fitting the images onto the key visual. Michael and Robert both used '13' as the number of humans required to match an average beluga's weight and have drawn this on the scale with male images. There is no record of their calculations so it is not possible to

know which data they used although most students worked with the teacher/librarian to review their arithmetic and to come up with an 'about' number to use. Regardless of male or female data, thirteen is within an acceptable range and Michael has correctly balanced the scale and used it as a source for his second sentence, "It will takes 13 people to weight as much as a narwhal". Despite the verb errors, this sentence is a good example of the successful combination of researched data and graphic task supporting student comprehension and writing.

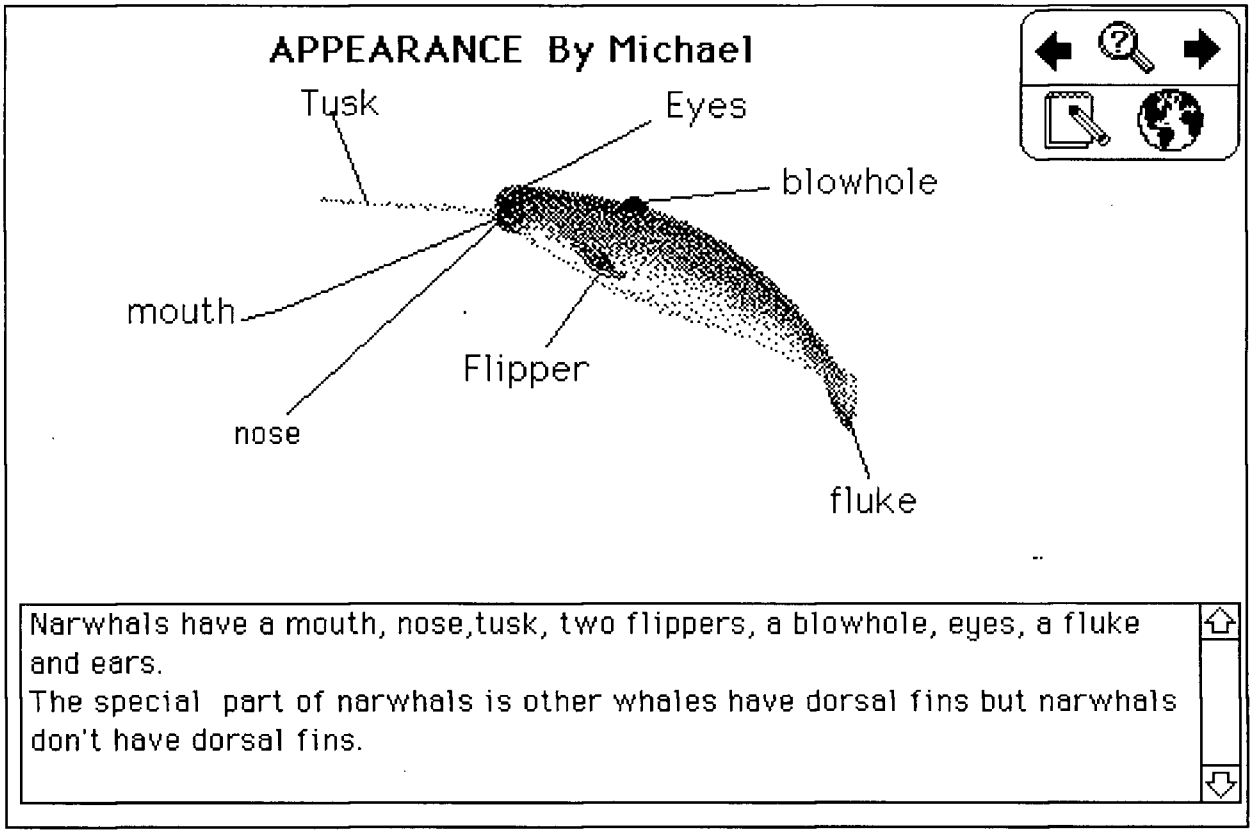
Michael's second paragraph follows the same two sentence pattern and draws first from the Notebook and then from the graphic to compare narwhal and human height or length. The length information Michael recorded in the Notebook is a complete sentence taken from one of the Internet resources. This process of copying large pieces of text from the Net was discouraged by the teacher/librarian and it is interesting that, despite having a complete sentence available for copying, Michael writes his own size sentence by following his first sentence pattern rather than simply repeating the sentence he found on the Internet. To complete the size graph Michael completed the vertical axis and then scaled the narwhal and human images to match. Stacking three humans to equal the narwhal is a very effective student innovation used by only one other student, David. The resulting sentence, "A narwhal is 3 times taller than a person", makes the sentence and graphic link very clear and is an example of a situation in which the card's design intent and the resulting student work are clearly matched.

Appearance Card:

Notebook

- colour =bluish gray in color distinctively marked with leopard-like spots.
- body covering =
- shape = like a can cylindrical body
- special parts =a tooth that grows into a long, spiral tusk that may reach 9ft
- other notes =no dorsal fin

Figure 2.3 - Appearance Card



The researching, recording and writing tasks for the Appearance card were organized around the knowledge structure of description. Comparing Michael's and Robert's Appearance cards offers some insight into the different ways students can use available resources to write their sentences. On this card, both students have virtually identical Notebooks and graphics, but very different sentences. Robert's six sentences are based entirely on the sequence of Notebook notes with no apparent reference to the graphic whereas Michael has only written two sentences with the first sentence linked to the graphic and the second to the Notebook. This difference in how the partners have completed the sentences is

partly explained by the process they appear to have followed and also by the different types of descriptive information contained in the Notebook and key visual. In this case, the graphic illustrates key terms describing body parts which was only one part of the Notebook content which also described colour, covering and shape.

In the observation log, the final Internet lab entry records that Robert was one of a few students who had completed the Appearance sentences before labelling the diagram. Since he wrote the sentences while looking at an unlabeled image of a narwhal it is not surprising that he referred to the Notebook rather than the incomplete graphic for information. A log entry from earlier in the month records that Michael was asking about what Appearance items to include on the diagram and that other students were asking for clarification about the "Label the key body parts..." sentence in the Drawing Instructions. While the entry says nothing about the work students had already completed on the Appearance card it seems likely that early in the month Michael labelled his diagram and matched the first sentence to it and that later he and Robert completed the Notebook at which time he added the final sentence. This process would explain the difference in their sentences. Michael's second sentence is also curious for its awkward construction and topic. His partner wrote two final sentences, "A special body part is its spiral tusk. Narwhal don't have dorsal fin", which seem to have been partly combined in Michael's last sentence, "The special part of narwhals is other whales have dorsal fins but narwhals don't have dorsal fins." While 'special part' and the lack of a dorsal fin are not parallel, Michael's use of 'but' creates a more interesting sentence than Robert's statement, "Narwhal don't have dorsal fin."

The different ways in which the students have completed this card and written their sentences shows a weaker link between the notes and graphic on this card's design compared to that of the previous two cards. On this card the Notebook and graphic are not as complementary and may be used independently as writing resources for the students; on previous cards the graphic and Notebook information reinforce each other and encouraged students to use both as writing supports. The lab observation notes make a similar point,

"Appearance was too unstructured and vague, students were uncertain and questioning of what info to seek vs trying to find each Notebook answer".

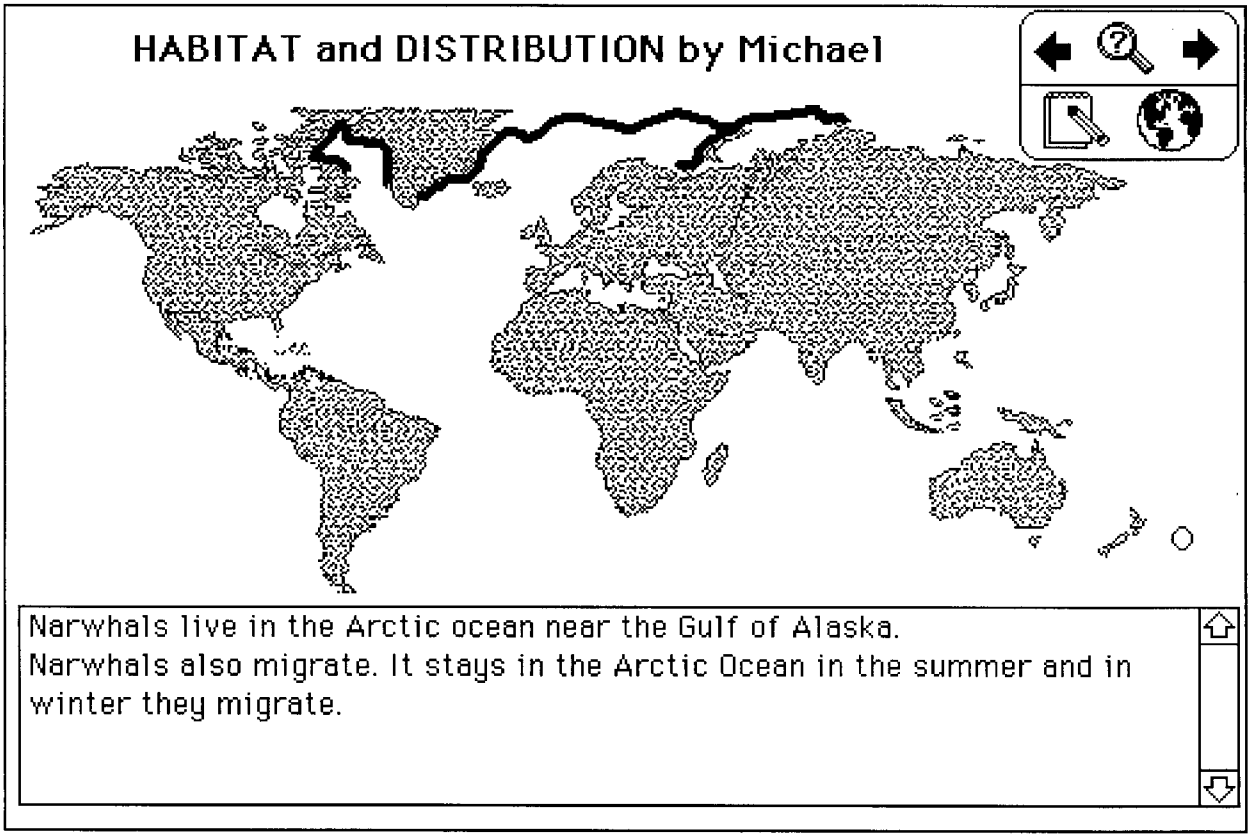
The potential of key visuals to identify comprehension gaps or to refine and reinforce correct understanding is also shown on Michael's card. He has incorrectly labelled the dorsal ridge as the blowhole. Unfortunately, it seems that this was not pointed out to him and he has not been able to re-visit the Internet resources to correct the error. This use of a key visual as an aide to comprehension was discovered by other students who were observed in moving alternately between the card and the browser window as they added and corrected details particularly on the Appearance and Habitat & Distribution cards. Cards such as Size and Adaptations (Beluga) contained a graphic task that required students to rework and represent the data in a new way. On these cards, the task helped the students think about the information and the key visual supported their sentence writing showing this understanding.

Habitat & Distribution Card:

Notebook

- Habitat tells you about the environment your animal prefers.
- Kinds of water bodies (deep or shallow water, warm or cold, etc.) =
- Distribution tells you where it lives around the world.
- Oceans =Arctic ocean
- Other locations (seas, bays, gulfs, straits, etc.) =gulf
- Migration tells you where it travels during the seasons. Find out if your animal migrates or stays in one place during the seasons.
- Migrates =yes
- If yes, summer =no
  winter =no Population tells you how many animals are living around the world.
- Population = population size for Narwhals ranges between 10,000 and 20,000.

Figure 2.4 - Habitat and Distribution Card



The scope and complexity of information contained on the Internet resource pages referring to habitat and distribution made both designing and completing this task a difficult one. From the design perspective, the attempt to provide notetaking prompts capable of

encompassing the range of data the students were likely to encounter complicated rather than simplified their research task. The change from cloze sentence note frames used in the Beluga Notebook to the collection of prompts used in this Notebook also seems to have complicated the task such that most students have written fewer sentences for this version of the card design. A single topic, such as 'where-the-animal-lives' for recording on the map and in the notes, would have been a more effective task and would have strengthened the link between the key visual and the Notebook. Thus, similar to the Appearance card, the graphic and the note tasks described different aspects of the content; the map showed location, the Notebook described habitat and migration. Michael's sentences and map demonstrate this gap.

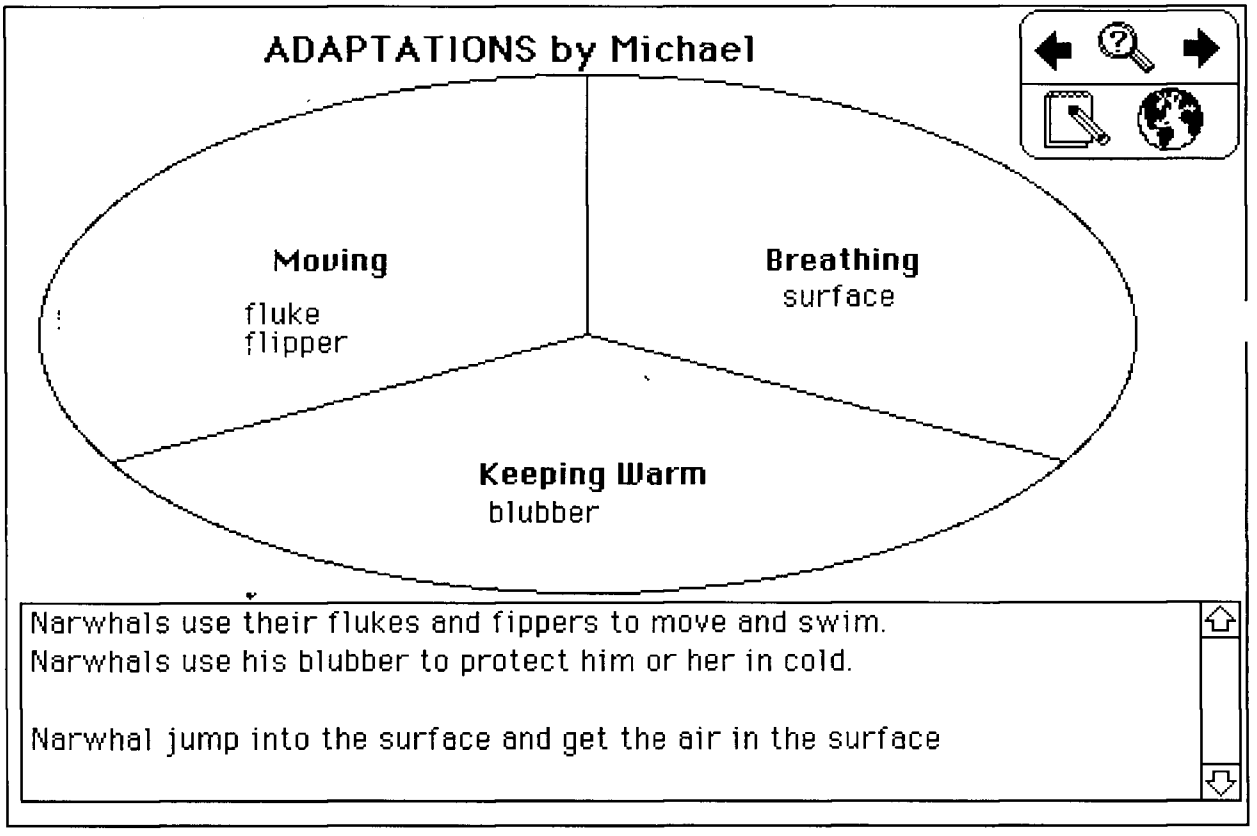
On the map, Michael has completed part of the job by marking areas of the Arctic ocean but he has not added the Arctic Ocean label that his partner included. His first sentence, "Narwhals live in the Arctic ocean near the Gulf of Alaska", is correct but highlights the gap between map and notes as it refers to places which have not been marked on the map. The second and third sentences show how Michael has been able to collect information and think about narwhal movements during the seasons but it is not clear that he understands that they remain within the Arctic ocean and do not make long migrations like some of the animals other students were studying. The population data that he recorded does not get included in a sentence. Although the students were able to complete the map and add information to the Notebook, the graphic and writing tasks did not reinforce each other.

Adaptations Card:

Notebook

- Moving =fliper and fluke
- Respiration (Breathing) = on the surface
- Thermoregulation (Body Heat) =a thick layer of blubber.

Figure 2.5 - Adaptations Card



Unlike the previous four cards, the generic Adaptations design shown in Figure 2.5 is very different from the design used for the Beluga Whale. Comparing Michael's work on both cards will help illustrate differences in the ways the two cards were linked to knowledge structures and differences in the ways they supported student research, learning and writing.

On this generic version of the Adaptations card, the Notebook and graphic are similar to the point of redundancy and are limited to descriptions of the three given categories rather than to the underlying knowledge structures such as sequence for breathing and principles for moving and keeping warm.

As shown in Figure 2.5, Michael recorded key Internet notes into the Notebook and then transferred these as key words onto the graphic. Since he recorded only brief notes, the transfer to the graphic required little work and no reinterpretation of the data. The three lines of notes and the three sections of the visual are similar representations of the content. Students who recorded more information into the Notebook and then reduced that to keywords had to do more interpretive work and the graphic may then have worked better as an aid to their thinking and writing about the ideas. Despite the redundancy between Notebook and graphic, Michael reconstructs three informative, simple sentences to link the note titles and keywords. The first two sentences follow the same pattern explaining what the narwhal uses the identified adaptation for. The third sentence explains where narwhals need to go to be able to breathe. None of these sentences use language ideas from the word bank since the kind of information Michael recorded does not match the samples in the Notebook. This gap between the information and the writing prompts is most obvious on this card where the word bank is both small and specific. Instead of providing a collection of words keyed to the three categories the word bank words presumed on the kind of information the students might encounter on the Net and offered phrases such as, "is able to; breathes through; can hold its breath for; stays warm because of". More helpful and more widely applicable language supports might have included 'for, by, with, at, because".

Figure 2.6 shows the work Michael completed on the Beluga Adaptations card. The differences between the Notebook tasks on the Beluga and Marine Mammal cards are very clear. On the beluga card Michael had to find specific numbers and words to complete the prepared sentences. On the generic card he had to find information to explain how the animal was adapted for moving, breathing or keeping warm and record this information in brief notes. The graphic tasks are also very different. The beluga adaptations key visuals are detailed, knowledge structure-based representations of the Notebook and Internet data. The diving graph and the breathing sequence strip required the students to demonstrate their comprehension of the information by representing it graphically. The graphic task on the generic Adaptations card only required students to move words from a three part list to a

three part diagram and abandoned the underlying structure of the content. Thus, the generic Notebook task was less structured and more difficult but the generic graphic task was simple and straightforward. However, unlike the graphic tasks on the previous generic cards and on the Beluga Adaptations card, it was not a true key visual representation of the content.

Beluga Adaptations Card:

Notebook

Diving:

Belugas usually dive about 20 meters deep.

I think people can dive about 10 meters deep.

A beluga dive usually lasts for about 15 minutes.

think most people could stay under water about 1 minute

Respiration (Breathing):

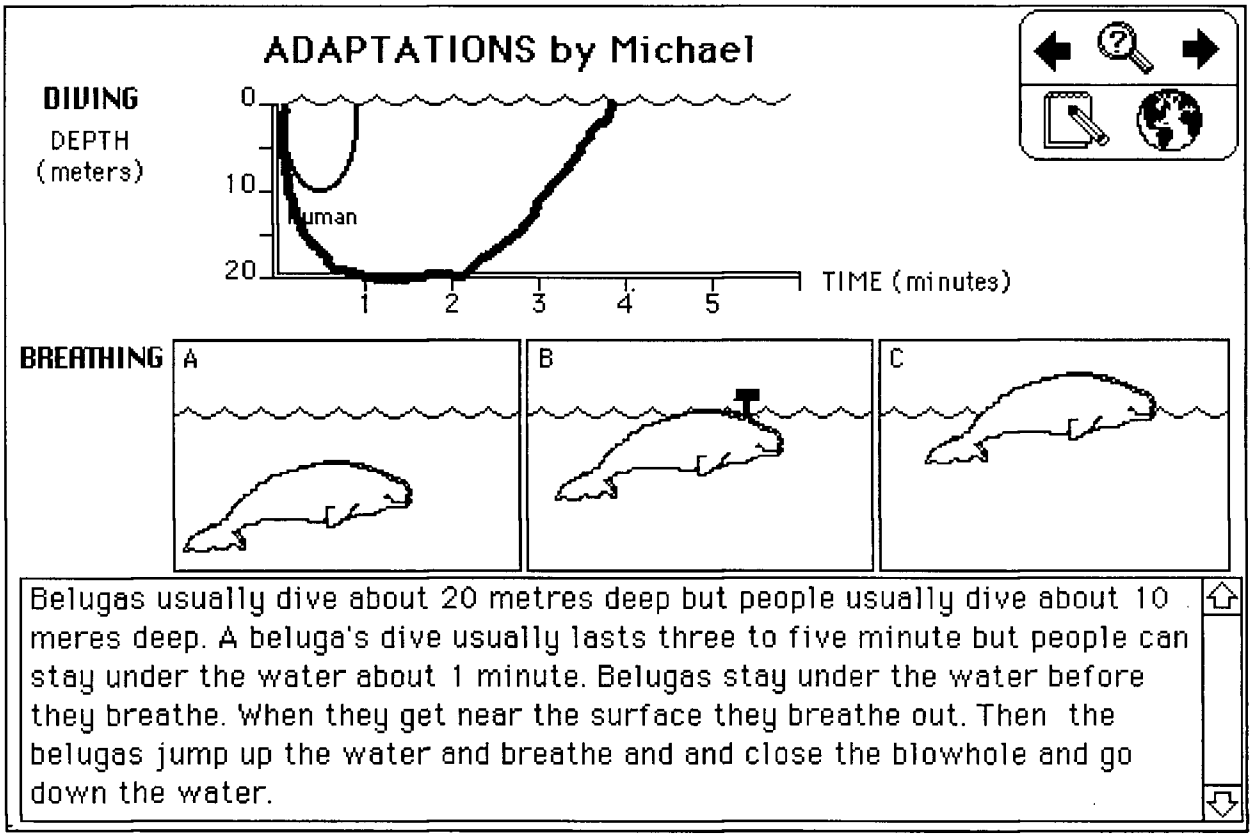
A beluga breathes through itsblowwhole

Draw and label the three steps showing how a beluga takes a breath.

Thermoregulation (Body Heat):

Body fat or ... helps ...

Figure 2.6 - Beluga Adaptations Card



Michael's sentences to describe beluga and narwhal adaptations show three types of writing task expectations. On the Beluga card set, Michael' sentences about beluga diving combined existing Notebook sentences with 'but' and are an example of the first type of writing task. While the rewriting job was not very difficult the research task was quite

challenging as the students had to extract the missing numbers from the following Internet text.

> B. Diving.
>
> 1. Beluga whales typically don't dive very deep, usually to about 20 m (66 ft.). Belugas are not generally thought of as deep-diving marine mammals, but they are capable of diving to extreme depths. Under experimental conditions a trained beluga whale repeatedly dove to 400 m (1,312 ft.) with ease, and even dove to a depth of 647 m (2,123 ft.) (Nowak, 1991; Ridgway et. al., 1984).
>
> 2. A typical dive usually lasts three to five minutes, but belugas can stay submerged for as long as 15 minutes (Nowak, 1991; Ridgway and Harrison, 1981).
>
> 3. In estuaries the usual diving sequence lasts about two minutes; the sequence consists of five to six shallow dives followed by a one-minute-long deeper dive (Ridgway and Harrison, 1981).
>
> (Sea World Education Department Resources, 1996)

The length and detail in the Internet text was very challenging for elementary ESL students but the Notebook sentence frames allowed the children to locate and record the key information and later to write sentences. Michael's compound sentences show his ability to follow the task instructions and use the writing supports to learn and write about abstract content.

The second type of writing task is found on the Marine Mammals Adaptations card. Students were required to reconstruct sentences from minimal notes with the varying degrees of graphic and Notebook support. Michael's sentences about narwhal adaptations are of this type and required more writing work since the Notebook and graphic notes were very brief and additional words were needed to create complete statements.

The third type of writing task, found on the Beluga cards, required students to write sentences which interpreted the graphic. These were the most challenging to construct since there were no model sentences in the Notebook and only graphic and Internet information to work from. Michael's sentences which describe beluga breathing are based on the teacher/librarian's introduction of sequence language examples served as a prototype of the word bank included in the generic Marine Mammals cards. These sentences are a good example of how a graphic can support student understanding of complex and comprehensive

information sources especially since the Internet resource on beluga adaptations contained approximately seven hundred words divided into four sections. The section on respiration quoted below begins with a description of the three breathing steps which the students used to learn how to draw the beluga in each of the sequence strip frames.

> C. Respiration.
>
> 1. A beluga whale breathes through a single blowhole, a modified nasal opening.
>
> a. The beluga whale holds its breath while under water.
>
> b. It opens its blowhole and begins to exhale just before reaching the surface of the water.
>
> c. At the surface, the whale quickly inhales and closes the muscular flap.
>
> 2. As a beluga whale exhales, seawater around the blowhole is carried up with the respiratory gasses. Seawater and the water vapor condensing in the respiratory gasses as they expand in the cooler air form the visible blow of a beluga whale. A beluga's blow is about 90 cm (35 in.) high (Slijper, 1979).
>
> 3. Beluga whales have a breath-hold period that is longer than a human's, and they exchange more lung air with each breath. (Sea World Education Department Resources, 1996)

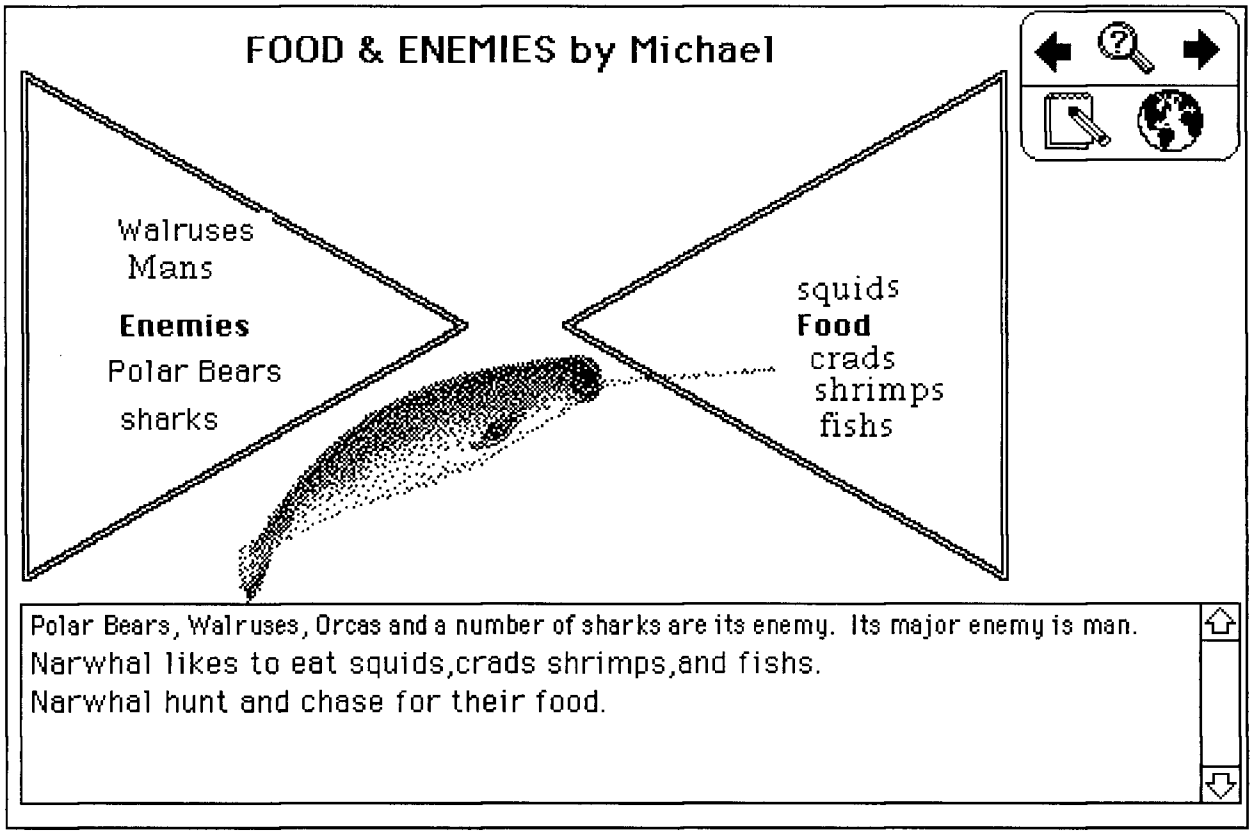
Michael's final three sentences, shown on the card graphic in Figure 2.6, explain the three breathing steps with unique words and sentence structures. He has not copied the Internet sentences but has first used the information to develop the key visual and then he has used sequence words 'when' and 'then' to describe the three frames of the graphic.

Food & Enemies Card:

Notebook

- what food it likes = squid, crabs, shrimps and fish.
- how and where it gets its food =they hunt and chase
- who its enemies are =Polar Bears, Walruses, Orcas and a number of sharks its major enemy is man.

Figure 2.7 - Food & Enemies Card



The format of this Food & Enemies card is similar to that of the generic Adaptations card with relatively complete Notebook notes to be reduced to keywords for placement on the graphic. As with the previous card, the graphic does not function as a key visual since it does not represent the knowledge structures which could have been linked to the Notebook prompts. The word order and smaller font size of the first two sentences show that Michael has copied segments of Internet text into the Notebook and then copied and pasted these directly into the card's text field. With the addition of a period, a capital letter and the

insertion of 'are' Michael turned these notes into sentences without having to do his own writing. This copy and paste process was discouraged by the teacher/librarian and didn't occur very often during the study; most students used the Notebook and graphic as places to rework the content and then reconstructed sentences from the information.

Michael has apparently edited the Notebook prompts by erasing the last prompt, '• how humans are helping or hurting this animal', and by rewriting the first prompt from '• what it likes to eat' to "• what food it likes". From this prompt he has written his third sentence by combining 'likes to' from the word bank with the list of foods from the Internet. In the sentence Michael repeats the 'crabs/crads' spelling error which likely occurred when he transcribed the Notebook list to the graphic. The last sentence is also from the Notebook without reference to the graphic. Michael did not write the usual final sentence about the animal's enemies. His Food & Enemies card has fewer sentences and a less elaborate graphic than his partner's card suggesting that he wasn't able to complete this card before the end of the term and of the study.

Quiz Card:

Notebook

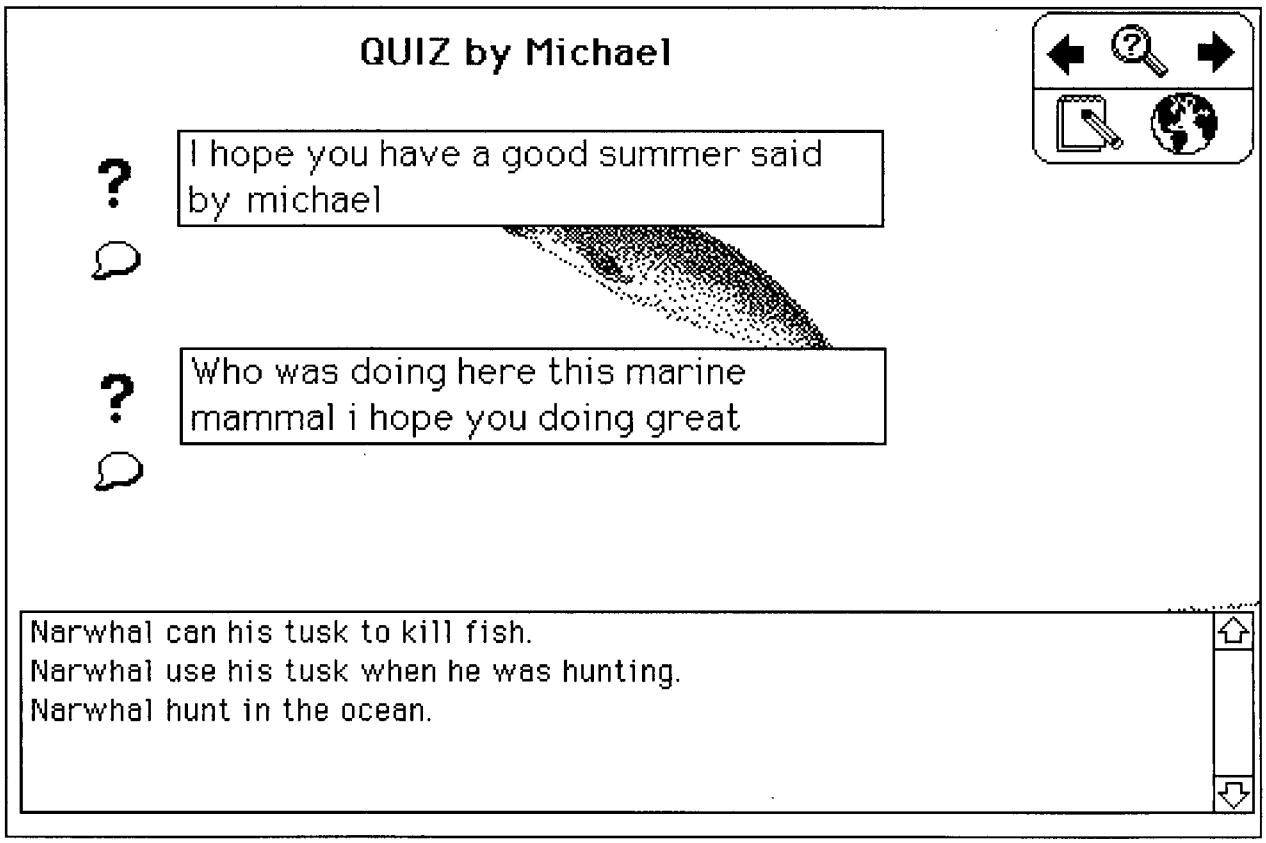
Words for Questions & Answers:

What can/is; What can his tusk do?

When does/is; When does it use his tusk?

Where does/ Where does he hunt?

Figure 2.8 - Quiz Card



Despite rewriting and condensing the Internet and HyperCard tasks for the students' generic animal research, there was not enough time to complete or even introduce all of the cards. The Quiz Card was one which the students were not expected to do nor was it introduced or explained by the teacher/librarian. During the Beluga research phase no use was made of the card. It was therefore surprising to discover that all of the students did some

work on this card during the independent research phase and further, that they had variously interpreted how to complete and customize it.

In Michael's case he appears to have used the Notebook prompts as a cue to write his own questions into the Notebook field; he has then answered his questions in the card's text field. After completing the Notebook and text fields it would seem that Michael discovered the pop-up question and question frames and decided to add his own message to these secret or hidden fields. The text in these two fields is a good example of Michael's conversational English level. While the message in the first box is clear enough the second field is somewhat confusing particularly the "Who was doing here this marine mammal" segment. This seems to be an extension of "by Michael" in the first field, an 'I was here' message, or it may be a question. The final note, "i hope you doing great", is apparently a wish or compliment paid to whoever might read the stack. The English usage in these fields is not sophisticated and serves to highlight the challenge the project's writing tasks presented to beginning Intermediate level ESL students. The level of English used on the unstructured Quiz card also emphasizes the success the children had in writing acceptable, research-based sentences.

The sense of ownership implied in the personal message Michael placed in the pop-up fields is also evident in the detailed graphic work done by all of the students who each took the time to modify fonts, scale, orientation and patterns of the visuals. This interest in extending and embellishing the assigned tasks is also evident in the work that each of the other students did on the generic Marine Mammals' Quiz Cards.

The original design intent of the card was to have students write two question and answer pairs based on the research they reported in the card set. However, most students added four or five questions and two or three answers. The questions and answers also reflected the students' interest and ability to extend their learning; while many of the questions were drawn directly from research they had presented on their cards, some students created entirely new questions and answers showing either their curiosity or the extra knowledge they had accumulated during the project. Questions which went beyond the original prompts included ones on communication, migration, life span and care of the young.

In most cases the students had found this additional information during their exploration of different Internet sites. In at least one case, a pair of students entered questions they were curious to answer about the animal and then proceeded to the Internet to find answers to these new questions. From the work that the students did in extending the content and uses of the Quiz card it is clear that they were successful content learners who enjoyed the work.

E. Student Interview Transcripts & Commentary

Interview Questions

The following interview questions were used to interview the student partners at the end of the unit work. Printed copies of each student's Marine Mammals HyperCard stack were laid on the table during the interview to assist the students in remembering, identifying and comparing the tasks and their work on them.

1. Tell me about some of the work you did on these cards.

a What was easy to do? Which cards were easy to do? Why do you think that was an easy card?

b What was hard to do? Which cards were hard to do? Why do you think so?

c What things did you like or not like doing?

d. When you were doing the computer work you were working on the Internet, on the Notebook, on the graphics or drawings and writing sentences. How did you like those jobs?

2. How did you feel about working in the LC computer lab and the Internet?

3. How would you compare writing sentences and paragraphs in the Marine Mammals HyperCard stack to other writing you do in school? What were you learning most about: computers, animals, English writing?

4. Where did you get the information or answers you needed for the animals you were studying? Where could you record your answers and write your sentences?

This question was used with the students just to confirm that they had understood and mastered the computer skills of working simultaneously in the browser and in HyperCard

windows. All of the children knew the answers to the computer questions and so their individual answers have not been reported here.

5. If you were starting to do a different school report, how would you choose to go about getting the information - go to the library, watch a video, use the computer and/or the Internet?

James & Harry

1. a Easy cards/tasks

Harry: "Size because Notebook tell about all the answers and picture"

James : "Habitat and Size because just a few questions, not too long and clear instructions."

Where were the instructions? Harry: "Notebook."

How did the drawings work for you, easy, hard, doesn't matter? Harry: "Drawing just make it easier because you can see."

1. b. Hard card/tasks

Harry: "Quiz like we had to say why, when, what - all the stuff - and we had to answer in sentences."

James : "Notes from Netscape sometimes hard some not so hard. Sentences can be harder because you had to think."

Didn't you have to think for the Notebook or Internet?

"Like sentences you had to think yourself not find for you."

Harry: "Yeah like if we found the notes then the sentences will easier."

2. Lab/computer work

Harry: "I like to do Internet, it was more fun because we learn about the mammals, look for Internet if more faster."

James : "I like to use computer is more better. In my old school no library just some books on box, no computer. When we first try it makes me feel good, more fun because it was a first time."

Do you think learning about things with the computer is an Ok, a good or a bad way to learn?

James : "Is good way, yes."

3. Writing comparison

James : "I like this one because of the Notebooks were easier to do, because there's more information to do. But in school sometimes you just use use your brain to do it and you don't have any informations to do it."

Harry: "I think we doing research we always use the brain and we - OK - its different cause we type it - if we type we will learn faster"

x. Where do you think the Internet information is that comes on the screen?

Harry: "Internet - the whole world."

Suzy & Millie

1. a Easy cards/tasks

Millie: "Size, Appearance and Food because it already almost had the answers, I don't have to find on the Internet , the Notebook had the help."

Suzy "The same, Size and Appearance. And Quiz because not so much questions. We don't have to open the Internet we could look at the Notebooks, back to Menu and click size to get that Notebook."

(Suzy illustrated the process she used to work on the Quiz card by pointing from the Quiz, to the Menu, then clicking her finger on the Menu card item she wanted to get info on, moving to that card and touching the Notebook to find an idea and then to the Quiz again.)

1. b. Hard card/tasks

Millie: "Classification because we have to find and the words are harder." (pointing to scientific word boxes.)

Do you mean the science words are hard here on the card or on the Internet page?

"Internet page."

2. Lab/computer work

Millie: "I like it. We can learn more things, we're not lonely."

What do you mean by lonely, that is the word you used isn't it?

"Like the Internet I never played and it was fun and we can learn more things, learn this and learn that."

Suzy: "Good Internet."

4. Which would you choose to use if you were working on a new topic to research, go to the library and get a book, watch a video, use the computer and Internet? Say you wanted to find out about a dinosaur?"

Suzy: "Internet because it's not so hard we just click on it and find it, but in the library we have to look all over the book. Internet we can get to the right place."

3. Writing comparison

Millie: "It makes you faster and when you erase it.gone not mess."

Suzy: "The same, typing."

Not about the typing or handwriting, what about the kind of writing we did in the computer and other school or classroom writing?

Millie "We not copy, just find the Internet and use they own English."

Suzy: "Notebook had words to help us make a sentence and some spelling."

Millie: "Internet is like a brain it has all the information like a brain, like a teacher, like dictionary - will tell me."

How is the Internet like or not like a book for information?

Millie: "It's more than a book, its easier to find."

David & Michael

1. a Easy cards/tasks

David: "Easy is Classification because the words was easy go to the Internet."

Michael: "Distribution because I find the map in the Internet.

1. b. Hard card/tasks

Michael: "Classification is hard to find it then I didn't understand the words."

David: "Adaptation."

1. c.

David: "I like the Notebook and pictures. The sentences is sometimes hard."

Michael: " Like doing sentences cause we just work from Notebook. I don't like to do the Notebook because it is harder to find the words on the Internet."

2. Lab/computer work, Internet/picture/Notebook/Sentences task comparison

David: "Computers is easy to find the information. The Notebook help making sentences and to get information."

Michael: "I'd rather work in computers cause its easier to search. We just type the word in and they will find it for us, but we have to find the books and find the pages, and pages and pages and that's harder. Internet you just click."

3. Writing comparison: What were you learning most about: computers, animals, English writing?

Michael: "Help me with my English writing - when we type we see the words and so the words just go in your brain and so its easier." (Points to imaginary screen and types with fingers.)

" English. We know the narwhal family names and like tusks, flippers; learned lots of words."

x. What would make the computer project better?

"Put more you search in the Notebook."

Allan & Helen

1. a Easy cards/tasks

Allan: "Size because we find a first page on the Internet, and like Habitat and Quiz."

Helen: "Yeah, Size and Appearance."

1. b. Hard card/tasks

Allan: "Classification, we found but it take a lot of time."

Helen: "Quiz because like you ask a question then you can't find the answer."

Do you mean you typed a question on the Quiz page and then went looking for an answer to that question on the Internet?"

Helen: "Yes."

(This is interesting since the students were not expected to get to the Quiz task given the late start to the project. They chose to work on the card regardless but had not had the card's task

idea explained to them and so they created a different kind of question. Instead of making a question based on their learning they made a new question about their animal and went looking for an answer. The information about what they had learned they typed into the text field as a series of statements.)

Helen: "Notebook hard because we have to find the information. Sentences easy because if you find for the Notebook you can found the information and it was easier to write your sentences."

Tell me how you used the card to write your sentences.

Helen: "Writing, you find the picture and we can know how long or what weight or what special."

(pointing to Size and Appearance card graphics.)

4. choose

Allan: "Computer because a computer is a fun thing to do and we can type the work and save it and if we bigger we can add the work."

Helen: "I think Internet and computer because like computer has like is easy to found informations they have lots of stuff. If you have Internet then the answer will be there. I think its easier in the computer. If we do it in the classroom we have books have many pages."

x. improve

Helen: "Notebook helped by having some informations to help us and picture help because we can see some informations."

x. learn most

Allan: "Animals and writing, both of it. Maybe we used the Notebook and some words help me and we can type it and change some and then we can learn."

F. Teacher/Librarian's Commentary

The following responses were provided in written form in answer to interview or survey questions.

1. Could you please comment on student language activities you observed in the computer labs, for example, speaking, reading, writing, notetaking, listening.

Speaking:

In partner work, I believe students tended to show each other "where, how and what" rather than to explain verbally.

Throughout the project, there was less speaking than I anticipated there would be. Most students seemed to quickly understand what was required and generally seemed to go about the task at hand independently, even when they had partners.

Reading:

Although the reading level on the Internet was sometimes well above the students' reading level, I was impressed by how well the students could ferret out information. There were, however, notable exceptions to this, such as when one student used the key words "dorsal fin" to describe the appearance of the narwhal. When questioned about it, the student was confident that the narwhal had a dorsal fin because he had read that it did. When he relocated the information, it stated, "the narwhal lacks a dorsal fin." There was at least one other occasion when a student had misinformation due to ignoring words which were not understood.

I didn't hear any students complain about the reading level on the Internet.

Writing:

I believe student writing was most successful when the student made sentences based on graphics that he/she had made. Writing from notes that the student had made was also successful, but if the student had copied sentences or more than just key words from sentences and pasted these into the template, writing was not as successful.

Notetaking:

Rather than "take notes" there was a tendency with some students to copy and paste sentences, or parts of sentences which contained more than just key words. This later affected the quality of their writing.

Listening:

Students listened attentively during times of group instruction.

2. Could you please comment on student graphic activities and tasks?.

Student graphic activities were an integral part of the project. I found they enhanced the understanding and appreciation of facts and concepts. They provided an opportunity to teach or reinforce computer skills and they gave students an opportunity to represent knowledge graphically. When it came time for students to write sentences, their graphics became a foundation for their writing. Based on my interaction with students, I believe that the graphic activities assisted in consolidating meaning and understanding.

3. Do you have any particular observations about student difficulties/challenges/questions and how these were addressed during the Internet/computer part of the unit?

Locating specific information:

This was addressed by adding sites which had the required information to the collection of sites made available to students, and by reminding students about the use of the Netscape "Find" button.

Identifying key words for notetaking purposes:

The Notebook was an excellent guide for students; it directed them to find the correct "information byte"

An attempt was made to prepare the students for notetaking by introducing key words in the library. This was not always successful as in the case noted above under "Reading" In this case, and in at least one more similar case, it was necessary to tell students not to overlook words which are not understood.

Getting meaning and understanding from Internet text:

The notes contained in the Notebook assisted students by defining words for them (for example "Distribution tells you where it lives around the world.") and by directing them to look for information which would enhance understanding.

As commented above, I believe that the graphic activities assisted in consolidating meaning and understanding.

Sentence writing:

Representing newly learned knowledge in sentences was a challenge. Student notes and the Notebook assisted students. But it seemed to me that the graphics were particularly useful as a tool for teaching language. For example, the Beluga Adaptations card led to a spontaneous lesson to a number of the students on words that convey order. As a teacher, it was gratifying to note that the students were successful in using the new language.

4. Do you have any comments to make about student successes or accomplishments?

- learning new computer skills related to Netscape
- learning new skills related to notetaking and writing in a digital environment
- following instructions
- locating information on the Internet and "making it their own knowledge" through notetaking, graphic representation and sentence writing.
- working cooperatively with a partner to achieve mutual goals
- publishing in HyperCard and in hard copy

5. Was there anything noteworthy about student use of and/or their ability or inability to use the Internet computers and software, Navigator and HyperCard?

I was impressed at how quickly the students became capable in their use of Netscape Navigator and in doing all their work in a digital environment; that is, they easily moved from HyperCard to Navigator and back again, to

search for information, take notes, make graphics, write sentences, check information, etc.

6. Teacher/librarians have long been involved in collaborative teaching and planning. Are there any comparisons you would like to make between this unit process and other co-op teaching and planning library research projects?

The process is essentially the same, however, there were some significant differences.

Notetaking:

In the Internet/HyperCard unit, the Notebook provides notetaking support to students. This was a successful strategy for teaching notetaking. There is no equivalent support given in the typical library unit.

Illustrations:

Student-made graphics provide language support during the writing stage; this does not happen in a typical library unit.

First Draft:

Language support is given in the Internet/HyperCard unit; student writing is based on the student's own graphics and notes, and also on help/support given in the Notebook. There is little or no language support in a typical library unit.

Editing/Good Copy:

The digital environment facilitates this process much more easily than the traditional library unit.

Presentation/Publication:

The end product of the Internet/HyperCard process has the potential of being shared with more people. This may have been a factor which enhanced student motivation.

7. Were there any notable student preferences or patterns of use?

Early in the project, the students developed the pattern of working independently; if given no instructions, they simply carried on from where they left off.

8. Do you have any other comments to make regarding strengths, weaknesses, improvements, next steps, etc.?

Strengths:

Student Graphics, for the reasons mentioned above.

The Notebook:

The Notebook is an excellent guide and teaching device.

Motivation:

The technology and content of the project captured the interest and enthusiasm of students. This interest and enthusiasm continued throughout the project. They appeared to be motivated to learn new skills and to understand instructions so that they could be successful in their work.

Near the completion of the unit (June 18), I asked the students which they liked best: using library resources to make notes and write sentences, or using Internet resources to make notes and write sentences, 8 of the 10 students answered "Internet resources".

Improvements:

Notetaking: More emphasis could be placed on copying and pasting key words only. (More preparation for this skill could have taken place in the library.) Early in the unit, I showed some students copying and pasting of whole sentences. There was then a tendency to indiscriminately copy whole sentences.

The effective teaching device of supplying the student with "words for description" and "words for classification" could be employed in the library component of the project.

CHAPTER 3: STUDENT PRODUCTS, PROCESSES & ANALYSIS

A. Introduction - Categories for Aggregate Text Analysis

The following 'numerical' analysis of the student's work was designed to summarize features of the content and process of student research and writing that emerged from a close reading of all of the cards the students completed before the end of the term and the end of the project. The goal was to show both where the students' drew their content knowledge from and how they used the different elements of the computer environment to assemble this information into a final written product. Various refinements on the basic analytical components were experimented with to establish a schema which was simple, consistent and revealing of the two dimensions of interest: how the resources were used and what student texts resulted. It was also considered important to make the analysis practical and related to marking criteria recognizable to practicing teachers both to reflect the development and execution of the unit and to make the interpretation meaningful. Table 3.1 summarizes these categories.

The application of these categories is presented in this chapter which contains the aggregate data and accompanying observations for each task card.

As discussed earlier, the project developed over two phases, initially, a specific Beluga research and subsequently, a generic Marine Mammals assignment applied to one animal for each student pair. The focus of the chapter will be an analysis of the relationship between knowledge structures, task design and the students' language use and development in each of these phases. Particular attention will be paid to the kinds of notetaking and graphic tasks and the link between these tasks and the expression of discourse texture in the students' writing.

B. Student Tasks

Beluga Research - Student Tasks

Internet-based research on the Beluga Whale was the introductory task set which developed student skills and provided insight into the strengths and weaknesses of some of the student tasks. Skills introduced in this phase included an orientation to the computer

Table 3.1 - Analytical Categories for Student Text & Graphics

CATEGORIES		CRITERIA / DEFINITION
NOTES	Notebook	- number of notes added to Notebook
	Graphic	- number of elements added to Graphic
SENTENCE CONSTRUCTION	Total	- number of punctuated or marked sentences
	Copied	- verbatim or virtual copy of Internet or Notebook text
	Reconstructed	- new sentence structure, reworked or reordered with additional semantic and textual language
	Original	- unique or novel student sentence
SENTENCE. TYPES	Simple	- basic subject and predicate
(Reconstructed and Original)	Compound	- two or more independent subject / predicate groups
	Complex	- one or more dependent clauses
SENTENCE SOURCES	Notebook	- sentence information is represented in Notebook notes
(All sentences)	Graphic	- sentence information is represented in the graphic window conceptually or as key words
TEXTUAL LANGUAGE	Total	- number of textual elements added by students
(Reconstructed and Original)	Textual Word list	- list of textual elements added
ERRORS	Quantity	- number of language errors in all sentences
	Error Types	- spelling, insertion, omission, verb, possessive, plural, vocabulary, construction
TOTALS		- sum, excluding Errors category

environment including the Internet, Netscape Navigator browser, HyperCard application and the Macintosh operating system. The content of the lessons evolved from the library unit which was concluding while the Beluga research was beginning. Student tasks in this phase mirrored the library unit format with the whole group introduced to and usually working on the same topic/task card. As noted before, student tasks in the Internet lab required more independence than those undertaken in the library, still, review and introduction of new tasks were often part of the teacher/librarian's opening of the Beluga lab sessions. Technical discussions and instruction about computer skills occasionally involved the researcher.

The original Beluga HyperCard stack contained eleven task cards plus a menu card. These cards presented the students with basic research topics which were expected to be duplicated in the subsequent and 'generic' marine mammals research assignment. As part of the collaborative planning and teaching process, observations and expectations of the classroom teacher and teacher/librarian were incorporated into the redesign of some elements of the Marine Mammals stack. The redesigned ideas, though not part of the original research plan, were realized in Internet and HyperCard computer format by the researcher. The generic Marine Mammals stack which resulted from this process was presented to students after they completed most of the Beluga work. In hindsight, these modifications provided an opportunity for further comparisons between similar and contrasting designs applied to the same topic by the same students.

Marine Mammals Research - Student Tasks

The Marine Mammals phase of the unit introduced a number of changes to both the student tasks and to the process for Internet research. Most of the changes were introduced in response to teacher observations and student feedback about the relative difficulty or success of the different card and task designs. Some changes were implemented to create greater consistency in the presentation of each card. Thus, each Notebook was changed to include the same three sub-titles, Notes, Words and Drawing Instructions, and the same type of instructions and expectations. The notetaking expectations changed significantly from various formats to a single notetaking format. For the Marine Mammals stack, each card, except Food and Enemies as noted below, contained only key word notes rather than sentence-like note frames. This modification was partly in response to the teacher/librarian's observation that the students' library-based notetaking skills focussed on recording only short notes, whereas, the computer's facility for copying and pasting any quantity of notes, combined with the kind of information presented in the Internet resources, invited the students to copy more text than was either necessary or comprehensible. To better match the previously taught notetaking style and to help students focus on critical information, the researcher modified the Marine

Mammals' Notebooks for six of the seven cards. The Food and Enemies card was overlooked in this change.

To complete the Marine Mammals cards the students' Internet work also changed. For the Beluga cards, the researcher identified appropriate Internet resources to match each topic card such that students could go directly from a particular task to resources matched to that task. Student Internet research in this phase began from a web page that duplicated the HyperCard workspace for that topic. By the time the students began on the Marine Mammals cards they were skilled computer users and much more capable Internet users. To meet these improved skills and to meet the classroom teacher's objective of helping prepare these ESL students for mainstreaming, the Internet resources were identified by site and not linked to specific topics, cards or pages. The effect was to require students to explore an information site, identify pertinent information and to record that information on the appropriate topic card. This was a more ambitious and challenging set of research skills and recording tasks than was presented to students in the Beluga project. These tasks were also more in keeping with traditional school research work and more closely matched to real world uses of the Internet. The essential difference between this research forum and many research assignments given to mainstream students was the provision of a structured environment designed to support the students' ability to select and record, think and write about key information.

Comparison of Beluga and Marine Mammal Tasks

The following table offers a comparison of each Beluga and Marine Mammals task card according to the Notebook and Graphic tasks. These descriptions were created after the students had completed the project and were not part of the planning process. This information will be the basis for selecting particular cards for comparison between the Beluga and Marine Mammals assignments and serves as a summary description of the students' tasks in the HyperCard and Internet environments prior to an examination of the aggregate, card-by-card data.

Table 3.2 - Comparison Beluga & Marine Mammals Stacks

CARD	BELUGA STACK	MARINE MAMMALS STACK
Classification	- 4 sentence-like note frames - key visual classification tree needing additional lines and frames	- 3 facts to record - key visual classification tree needing names and lines
Size	- 2 facts to record - 1, 2-part cloze sentence frame - 2 key visual graphs, size and weight	- 2 facts to record - 2 key visual graphs, size and weight, new scale and graph requirement
Appearance	- 4 sentence-like note frames - key visual diagram, labels to add	- 5 notes to record - key visual diagram, labels to add, new requirement to locate and copy image from the Net
Senses	- 3 sentence-like note frames - key visual diagram to mark	- omitted from generic stack
Habitat & Distribution	- 5 sentence-like note frames - map, areas to mark and label	- 6 notes to record - map, areas to mark and label
Adaptations	- 7 sentence-like note frames - 1 key visual graph, diving - 1, key visual 3-frame sequence strip	- 3 notes to record - 1, 3-part note form - not completed by all students
Food & Young	- 3 part note form	- changed to Food & Enemies - 4 sentence-like notes - 2 part note form
Age & Enemies	- 1 sentence-like note - 5 notes to record - 3-part note form	- see Food & Enemies above
Quiz	- 2 question and answer frames - not used	- 2 question and answer frames - 5 question starters - not taught, but used by some students

C. Beluga Stacks Summary Data

The following tables present raw score and percentage data for each category, summed for each completed student card and converted to a percentage for each student card. The percentages for sentence Type and Textual Language are calculated against the students' own Reconstructed and Original sentences. The numbers are actual and not pro-rated according to the number of students since three incomplete cards, out of a total possible data set of eighty-eight cards, are unlikely to have significantly altered any of the major results. The data results

from a close study of each of the design components of each students' work including the Notebook notes, the card graphic or key visual and the final set of sentences.

Table 3.3 - Beluga Stack Raw Score Data

CARDS:	Class	Size	Appear	Sense	Habit.	Adapt.	Food	Enem.	Total
NOTES	76	87	152	47	77	125	42	65	671
SENTENCES									
Total	55	38	59	44	42	55	39	49	381
Copied	30	23	28	22	34	27	17	20	201
Reconstructed	5	10	14	13	6	6	19	5	78
Original	20	5	16	10	2	22	3	24	102
TYPES									
Simple	20	14	25	16	4	12	21	23	135
Compound	3	1	3	4	1	14	0	4	30
Complex	2	0	2	2	3	1	1	3	14
SOURCES									
Notebook	39	33	51	37	40	30	37	47	314
Graphic	16	5	10	7	1	27	1	2	69
TEXT. LANG.	7	6	5	10	7	32	2	7	76
ERRORS	25	41	46	29	31	42	27	55	296
STUDENTS	11	11	11	9	10	11	11	11	

Table 3.4 - Beluga Stack Percentage Data

CARDS	Class.	Size	Appear.	Sense	Habit.	Adapt.	Food	Enem.
SENTENCES:								
Total	55	38	59	44	42	55	39	49
Copied	55%	61%	47%	50%	81%	49%	44%	41%
Reconstructed	9%	26%	24%	30%	14%	11%	49%	10%
Original	36%	13%	27%	23%	5%	40%	8%	49%
TYPES								
Simple	80%	93%	83%	70%	50%	43%	95%	79%
Compound	12%	7%	10%	17%	12%	50%	0%	14%
Complex	8%	0%	7%	9%	38%	4%	5%	10%
SOURCES								
Notebook	71%	87%	86%	84%	95%	55%	95%	96%
Graphic	29%	13%	17%	16%	2%	45%	3%	4%
TEXT. LANG.	28%	40%	17%	43%	88%	114%	9%	24%
STUDENTS	11	11	11	9	10	11	11	11

Notes, Totals & Errors

The Notes tally included Notebook and Key Visual elements and is a useful indicator of the relative amounts of work and detail required for the different task cards. It is a somewhat more detailed count which represents to teachers the amount of work completed by each student and its genesis was a rough checklist to monitor student progress. The final, horizontal row of totals similarly represents the overall amount of work completed for each card. Inspection of the Notes data shows that the cards requiring and generating the greatest amount of notebook and graphic work were: Appearance, Adaptations, Size, Habitat & Distribution and Classification. The first three expected a considerable amount of computer drawing work and each of the cards had a number of notetaking points in the Notebook window. The unusually high numbers for Appearance and Adaptations highlight an imbalance in the task expectations as each of these cards had approximately six graphic and six notebook points as compared to other task cards which usually had only three or four notes and graphic points. These higher quantity expectations required students to spend more time on these cards and are likely to have influenced the high tallies recorded in many sentence sub-categories.

The Errors row is a simple count which again reflects a common overview applied by teachers. It should be noted that specific or remedial language instruction aimed at reducing the number of errors students might make in writing their sentences was not part of the research objectives. Addressing problems with particular writing errors was part of the regular process of working with the students' language development while they were learning and writing about their research content. The analysis of recorded errors is therefore aimed at providing insight into the nature and possible effects of the different research and writing tasks. To account for changes in the number of students and to make a rough comparison of the range of errors for the different tasks, a percentage comparison with the number of sentences was calculated and is summarized in the following table. These figures are averages and are therefore only useful as a general guide since the errors were not tallied on a per sentence basis.

Table 3.5 - Beluga Sentence Errors by Card

Class.	Size	Appear.	Sense	Habitat	Adapt..	Food	Enemies
45%	107%	78%	66%	74%	64%	70%	112%

The range of percentages is consistent over five of the eight cards where two-thirds to three-quarters of the sentences produced were likely to contain language errors of the types commonly noted by teachers. Two cards, Enemies and Size, generated higher than average percentages and one, Classification, generated a lower than average number of errors.

The low errors result for the Classification task may relate to the kinds of sentences produced. About seventy-one percent included segments of text from the Notebook and fifty-five percent were marked as using these elements to create copied sentences. The Notebook contained four nearly complete potential sentence frames to describe the beluga's scientific names. These frames only required the addition of a few words from the Internet reference before being transferred to the sentence field. While it was possible to copy the text from the Notebook and paste it into the writing field most students were observed to re-type the sentences instead. The re-typing process introduced some transcription errors and a chance for their English usage level to reveal itself. Generally, pupils were able to produce relatively error free sentences by this process and thus contribute to the low tally for this card. The following four examples from different students typify the kinds of 'copied' sentences written by this process. They include some typical spelling or verb errors and match the four note frames. "All whales belongs to the scientific order cetaces." "Odontoceti tells us that belugas are toothed whales." "Delphinapterus meansthat belugas are 'dolphin without a fin." "Leucas tells as that belugas are white."

The remaining forty-five percent of the sentences were counted as original or reconstructed and eighty percent of these were simple sentences that the students were generally familiar with from their classroom and library work, for example, "Belugas are mammals. They are vertebrates." These sentences could be formed in two ways. Directly from the graphic, as the previous examples show, or, by reconstructing a Notebook sentence frame. Reconstructions tended to shorten the frames into statements such as, "They don't

have a fin. Belugas are white colour." The sentence-like note frames, the students familiarity with simple statements about an animal's class and the key visual all assisted the students in avoiding errors on the Beluga Classification card.

The high error results for the Enemies and Size cards also require some explanation. On both of these cards the Notebook format was different from that on the Classification card with point form and factual notes for eight of ten items and with only two sentence-like notes for the remaining ideas. Since nearly complete sentences were not available for most of the information the students collected, they had to complete sentences either by referring to the factual notes or to the graphic. Reference to the notes would result in a high Notebook count which is exactly what occurs. On both cards, student sentences contained a high proportion of Notebook source sentences . A survey of the kinds and locations of the errors on these two cards shows they were fairly evenly distributed between types of sentences (copied or original) and that similar kinds of errors were common to both cards. Most of the errors were either omissions, plurals, verbs or possessives. These common errors resulted when the students copied sections of text from the Notebook as if they were complete or correct. An example of a reconstructed sentence with errors is, "A male beluga average weight 1360 kg." The underlined words are drawn from the Notebook without being corrected to read, "A male beluga's average weight is 1360 kg". Another example showing an original sentence and its Notebook source is, "Predators, killer whale, polar bear" turns into "Killer whales and polar bear prey beluga." In this last example the student correctly adds 's' to whale but forgets to do so for 'bear' and 'beluga' and omits to follow 'prey' with 'on'.

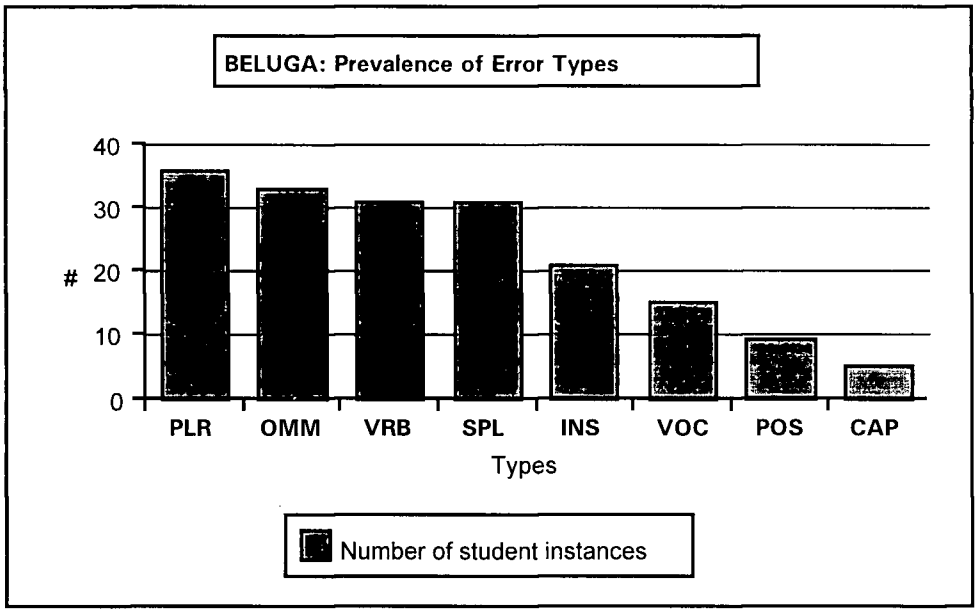
From the Enemies card, the next example shows the difficulty one student had expressing a sophisticated idea correctly. The Notebook note said, "• oil exploration change the habitats", which is developed into, "The oil exploration leak the oil into the ocean, change the belugas' habitats." This sample was marked for five errors of insertion, omission, verb agreement. Particular instruction on editing notes was not given nor were on screen language supports offered. Thus, the students struggled to create correct sentences from the available language. While the students made many improvements to convert the notes into sentences

there were many changes which needed to be made and the distinctions between some of these words were quite subtle. For example: beluga, belugas, beluga's; weight, weigh; average, an average.

The relatively high number of errors on the Size and Enemies cards therefore seems to relate to both the kinds of Notebook support presented to the students and to the difficulty of the some of the ideas and the associated language.

Figure 3.1 sums the kinds of errors made by each student for each card and shows the most to least common errors within the group of students. It does not represent the frequency of errors but rather the prevalence of each type of error based on how many students made each kind of error.

Figure 3.1 - Beluga Stack Error Types



PLR = plural	INS = insertion
OMM = omission	VOC = vocabulary
VRB = verb	POS = possession
SPL = spelling	CAP = capitalization

The graph is not intended to compare student errors in this situation to errors in other situations as there is no data for such a comparison. Of interest here is that the one category

related to comprehension,Vocabulary, which recorded incorrect, confusing or inappropriate choice of words, is one of the least prevalent. The other categories relate more to the students' technical language proficiency which was not considered to be very high by the classroom teacher who was able to compare this group of ESL students to children from previous years who had worked on similar library and computer research projects.

Student Sentences

The comments which follow explore some of the aggregate data results and point out the implications of these results to the nature and quality of the task design and the language and content learning of the students.

Four blocks of data relating to the nature of the students' sentence writing are explored in this section: 1) Sentence Construction; 2) Sentence Sources; 3) Sentence Types; 4) Textual Language. These categories were outlined at the beginning of the chapter; additional explanations are included in the preface to each sub-section. Each of the categories is used to help reveal the process of sentence building evidenced in the relationship between the text and the other elements of the students' workspace.

Sentence Construction

The Sentence Construction category compares the elements of the students' sentences to the elements present in the writing supports to identify a probable writing process used to construct each sentence. The three sub-categories, copied, reconstructed and original, are not arbitrary but neither are they exclusive. They could easily be expanded to four divisions to account for sentences between entirely copied and entirely reconstructed, or, as easily conflated into two large divisions: copied and authored. Three divisions were maintained in the summary tables to highlight cards where students' sentences were most wholly original without obvious reference to the Notebook language sources.

Sentences which were copied verbatim or which were re-assembled in identical but re-ordered segments from the Notebook into the writing window were evenly distributed over seven of the eight of the task cards. The Habitat and Distribution card with the highest percentage of copied sentences (81%) doubles the number of the lowest card, Enemies (41%)

and is twenty percentage points higher than the next card in the sequence, the Size card. Other cards fill the space between the Size and Enemies cards with steady increments of between three and five points. The following table summarizes these results for each card.

Table 3.6 - Beluga Copied Sentences by Card

Hab/Dist	Size	Class.	Senses	Adapt.	Appear.	Food	Enemies
81%	61%	55%	50%	47%	47%	44%	41%

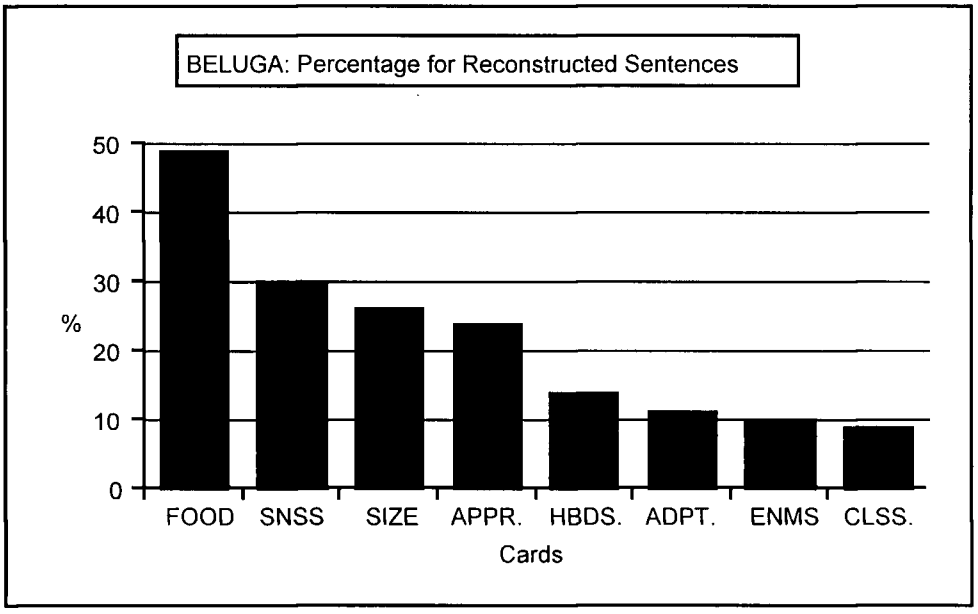
While the following discussions will look at the relative proportions of sentences in each of the sub-categories it is worth noting that copied sentences was the largest single classification for most cards. For half of the cards the copied category accounts for the majority of the sentences written and for the remaining cards, the percentage of copied sentences remains close to fifty percent.

A brief look at the Notebook and visual for the Habitat and Distribution card explains the high percentage of copied sentences. First, each of the five note frames in the Notebook was a ready-made sentence such as, "There are about ... belugas in the world." These required the addition of only one or two words before they were ready to go into the text field. Second, the world map instructions did not expect the students to develop the map with direction and location information that would have enabled them to more easily write sentences using the map as a reference. Instead, the map instructions simply asked for locations and possible migration paths to be marked. Many students were not able to complete even these instructions as most of the Internet resources did not include maps. With appropriate instructions and resources, the map task could have functioned as a key visual but it became more simply an illustration on the card. Finally, the number of Notebook sentences on this card exactly matched the number of visible lines in the writing field; once a student had completed the Notebook frames and entered them into the writing field the writing part of the card task looked complete. As a result, the Habitat and Distribution card showed the lowest percentage of original sentences at only five percent. While both the

Notebook reference and copied sentences were high at ninety-five percent and eighty-one percent respectively.

Reconstructed sentences, where a student reworked the Notebook contents into a more unique sentence were also very low for this card at only fourteen percent. This is in keeping with the fact that most of the notes were already sentences so the students had little reason or incentive to rewrite them. The following chart summarizes the percentages for reconstructed sentences for all Beluga cards.

Figure 3.2 - Beluga Stack Reconstructed Sentences



The chart makes clear that the cards fall into three groups: those which encouraged the students to reconstruct sentences from the Notebook (Food), those which supported the process (Senses, Size, Appearance) and those which discouraged it (Habitat & Distribution, Adaptations, Enemies, Classification).

The last group, defined as providing disincentives to reworking Notebook information, includes the Habitat card which has already been discussed as discouraging reconstruction by providing ready made sentences frames for copying. This situation holds true for Classification and Adaptations which provided four and seven sentence-like, copy-ready note frames. As would be expected, the copied sentences for these two cards are also

high with Classification at fifty-five percent and Adaptations at forty-seven percent. The Enemies card only provided one sentence style note and asked students to list five other, one or two word facts. The result is that there was little for the students to copy verbatim, hence the relatively low figure of forty-one percent copied, and even less to reconstruct from phrases, ten percent reconstructed. The students had to develop short notes into complete sentences and consequently, the Enemies card produced the greatest number of original sentences.

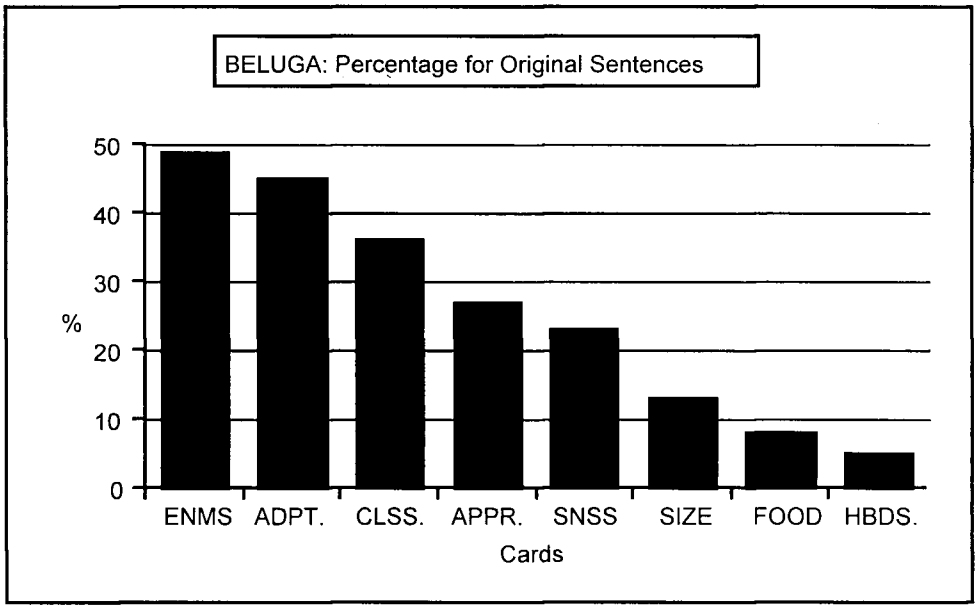
Comparing the Notebook and graphics of the remaining cards shows a split between the Food card, with no visual and only categorized notes to work from, and Senses, Size and Appearance with both notes and a key visual. Looking first at the three cards, it is notable that, with only one exception, they appear in the middle range for each of the three sentence construction categories (copied, reconstructed, original). The exception is the Size card with a low number of original sentences (see the following section). This would suggest that these cards provided students with a range of different supports which could be variously used to help with the sentence writing task. The card descriptions, summarized earlier in Table 3.2, confirm that each of these cards included a combination of sentence-like note frames, facts or labels and a key visual graphic. The resulting mix of processes for creating sentences matches this range of supports available for students to choose from.

Turning to the Food card, with the highest percentage of reconstructed sentences, there is a superficial similarity between it and the Enemies card as both have three, labeled text fields as on-screen rather than concealed notetaking spaces. However, the Notebook instructions on how to fill these fields and the way the students filled them were quite different. As noted above, on the Enemies card the students entered one or two keywords into the note fields and used these to write their own sentences. On the Food card, virtually all of the students copied longer phrases from the Internet resources into the note fields and then used these to 'construct' their sentences. For example, in the 'Where' field, most students entered 'near the bottom' or 'near the bottom of the ocean', rather than a single word. The sentences they then wrote would contain the whole phrase and thus be counted as

reconstructed rather than original or wholly copied. This process for sentence construction seems to have predominated for this card hence the relatively high result of forty-nine percent.

The final sentence construction category to discuss is original sentences which are defined as those which reflect the card topic and resources with no evidence of having been copied, or reconstructed from large segments of pre-existing text in the notes. The results for this category, converted to percentages, are ordered and summarized in the following chart.

Figure 3.3 - Beluga Stack Original Sentences



The spread of figures represented in the bar graph suggest four natural groupings with Size, Food and Habitat & Distribution in a category which did not induce students to write a very great percentage of their own sentences. Reasons for this situation regarding the Habitat & Distribution card have already been ascribed to the readiness of the sentence-like notes for copying. Similarly for the Food card, where the on-screen, phrase length notes encouraged students to reconstruct rather than author sentences. The Size card appears to combine both of these reasons. That is, the card's Notebook contained one ready-made, two-part sentence which was amenable to copying into either one or two sentences, and, it also held four additional facts with accompanying phrases. The fact that there were any original sentences can probably be attributed to the strong key visual.

The next group of cards includes Senses and Appearance with twenty-three and twenty-seven percent of the sentences counted as original. These cards have a nearly identical profile for each sentence construction category standing in the middle range and having very similar percentages for each sub-category. Not surprisingly, they are virtually identical at the card level where both show a Beluga diagram ready for labels and lines and at the Notebook level which had three or four sentence-like notes. Since the notes appear to account for the copied and reconstructed sentences it is reasonable to predict that the diagram should be one source for the students own sentences. Indeed, the percentage of sentences attributed to the graphic for both cards is once again nearly identical at sixteen and seventeen percent and the cards again fall into the middle range when compared to the other eight tasks. A quick examination of the students' sentences confirm that many of the original sentences on these cards are directly linked to the visual. On the Appearance card, the notes refer to a beluga's colour, flippers, rostrum, melon and blowhole but students added sentences on flukes, eyesight, size and the location of various parts: "Belugas has good eyes and they can see very well."; "Belugas use the flukes to swim"; "Belugas have thier blowhole on the top of thier head."

On the Senses card the link to the graphic is less apparent, perhaps because the visual concentrated only on the sense of hearing, but the students created original sentences in a different way, by extending the Notebook sentence pattern. Students used this process on both cards but it is particularly obvious on the Senses card where the Notebook compared human and beluga hearing and some students wrote original, but parallel sentences on other senses: "Belugas can see into the water but humans can't see very well in the water." Original sentences only accounted for approximately one quarter of the children's writing on these cards but it shows their ability to extend even limited support material into new language.

Enemies, Adaptations and Classification fall into the final, higher percentage category for original sentences. Probable explanations for these results are similar for the Classification and Adaptations cards but different for the Enemies card. As has already been pointed, the Enemies card provided only one sentence-like note frame suitable for copying and the students

recorded at least five short or single word notes which were insufficient to be considered reconstruction material. The result is that the majority of the sentences written on the Enemies card were classified as original; forty-nine percent compared to forty-one percent for copied and ten percent for reconstructed. These original sentences developed the short notes from the three note fields into longer sentences. Richard recorded 'hunted, make toxic chemicals, habitats' in the Human Actions field then wrote these sentences. "Toxic chemicals can kill belugas and other animals. Belugas habitat in the arctic ocean. Human hunted belugas." There are other observations to make about the content knowledge and the correctness of the sentences but these are extra to the fact that these are Richard's own sentences.

The Notebook and Key Visual environments on the remaining two cards were substantially different from that on the Enemies card. On both the Classification and Adaptations cards the Notebook contained a mixture of phrases and sentence frames suitable for copying but too long to be counted as reconstructed. Copied sentences for Classification equalled fifty-five percent with forty-seven percent for Adaptations. Reconstructed sentences were rare at nine percent on the Classification card and eleven percent on the Adaptations card. The remaining original sentences are a major proportion for both cards at thirty-six percent on Classifications and forty-five percent on Adaptations. The source for these sentences was the card graphic. For both cards the graphic was a true key visual representing the structure of the content. The scientific classification of Beluga whales was represented by a tree diagram. This chart conveyed relationships and information not contained in the Notebook window showing whales as part of the mammals, vertebrates and living things groups. It was this information that the students included in their own sentences such as, "Belugas are living mammals in the ocean. belugas are vertebrates", "Belugas are mammals that live in the water."

The Adaptations graphics were also key visuals. The first was a graph comparing human and beluga diving by depth and duration. Students learned to read the human line on the graph and enter information from it into their Notebook and they then used the Internet

to locate the comparable information for the Beluga. This information was then drawn onto the graph. However, this key visual did not generate many original sentences since the Notebook, when completed, contained ready-made sentences about this information. Students either copied or used these as a reconstruction resource. The second key visual on the Adaptations card had no supporting Notebook notes. It was an empty, three frame action strip to show the sequence of how a beluga breathes. The Internet resources had the information as text and the students were able to use this information to complete the visual. They then used the visual to write their own sentences. Before writing these sentences the teacher/librarian introduced some sequence terms such as, first, second, next, last, which the students also included in their writing. Although two students used some of the phrases from the Net to construct sentences, most wrote original sentences. Allan's sentences are a good example, "A beluga breathes in three steps, the first step is go up to the top of the ocean. The second step is they open the blowhole the air comes out, then they jump up and take a breath. The third step is they go down and close the blowhole."

This review of the Beluga task cards and their relationship to sentence construction suggests that the types and combination of supports available to the students has a clear influence on the process students follow in their writing. In the Beluga card set, students copied whole sentences or constructed sentences from phrases when those were available in the Notebook and they wrote original sentences when the Notebook contained only keyword notes or when the graphic carried additional content or conceptual information.

The following sections look more briefly at the remaining sub-categories and expand on comments and observations already made.

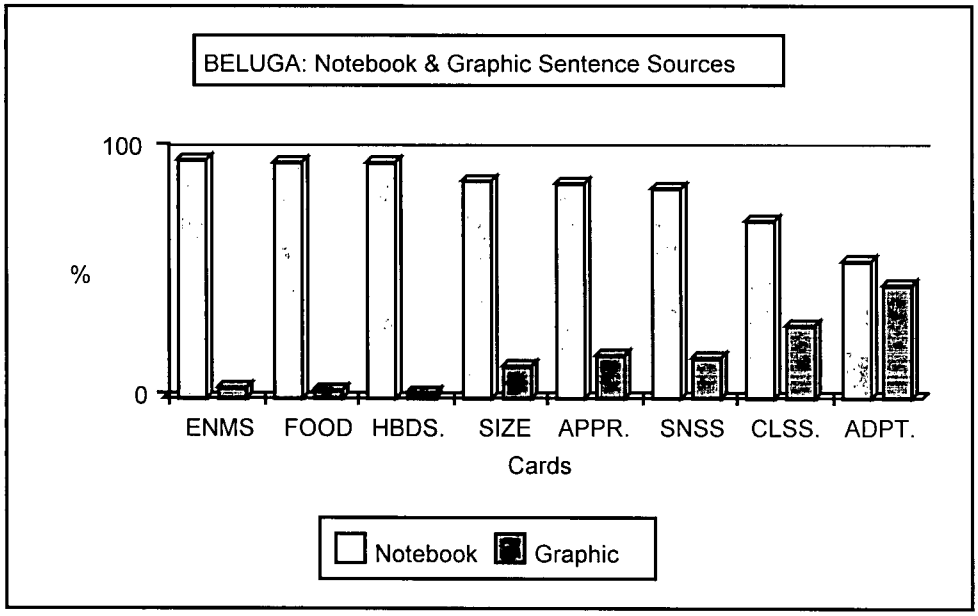
Sentence Sources

The Sentence Sources data looked for language that could be clearly attributed to either the Notebook or the Graphic. In cases where the language or concept was present in both locations, both categories were recorded, in these situations total Notebook and Graphic items could exceed total sentences. The Sentence Construction data counted language that was derived from the Internet via the Notebook or from the Notebook's notetaking supports and

instructions. If a student's sentence did not contain elements obviously drawn from these language locations then the sentence was usually coded original. While it was technically possible for a student to copy whole sentences from the Internet directly into their writing field without the intervening step of recording the information as notes, this process was discouraged and students were encouraged to record notes from the Net into their Notebook. Students who were actively working in the writing frame were most often observed working between the Notebook and the graphic windows rather than the Internet window. Sentences with suspiciously few errors or advanced vocabulary or syntax were checked against the Internet sources thus the chances of an original sentence being incorrectly attributed to the student is probably small.

To provide a picture of the interaction between textual and graphical information available in the pupils' workspace a tally was made of the evidence of these two sources in the students' writing. The following charts summarize the results by combining the percentages for each category into one graph.

Figure 3.4 - Beluga Stack Notebook & Graphic Sentences



Although the definitions for the sources were not exclusive, it is apparent from the opposing trends shown in the graph that there was a simple inverse relationship between the

students' use of the Notebook and Graphic as sources for their writing. The design of many of the cards reinforced this division by concentrating sentence support information in either one location or the other. Thus, cards with the highest percentage of Notebook derived sentences are those with graphics which either had no supporting visual or which did little to encourage the students to refer to the visual. The Age & Enemies card and the Food & Young cards are the most obvious examples of this situation as both cards moved the majority of the textual information from the Notebook to the screen where it was contained in three, labeled text fields forming a type of idea web. This type of web helps organize the information but does little to convey relationships, underlying concepts or other content features representative of a key visual. In coding these sentences, information which was clearly derived from the text fields was thus counted as a part of the text Notebook rather than as a part of a graphic.

On the remaining six cards the graphics were various types of key visuals and the evaluation of the students' sentences looked for evidence of a link to either the Notebook or Graphic categories. As was previously mentioned, the Habitat & Distribution card's world map could have been made supportive of student writing but was given little attention in the student instructions and was not completed to a point where it might have generated more student writing. The result is that the map is ignored in the children's writing and the majority of sentences are drawn directly from the Notebook information: ninety-five percent Notebook; two percent Graphic.

The Appearance, Senses and Size cards fit in a middle range while the Classification and Adaptations cards showed the greatest evidence of graphic use for creating sentences Each of these cards contained sentence style Notebooks which provided convenient support for copied or reconstructed sentences that fulfilled most of the cards' requirements. When students chose to write additional sentences in this context, the graphic was at least capable of providing ideas and was used as such. Examples and discussion of sentences drawn from the graphic from these cards have already been given and are summarized in the following table.

Table 3.7 - Beluga Stack Graphic Source Sentences

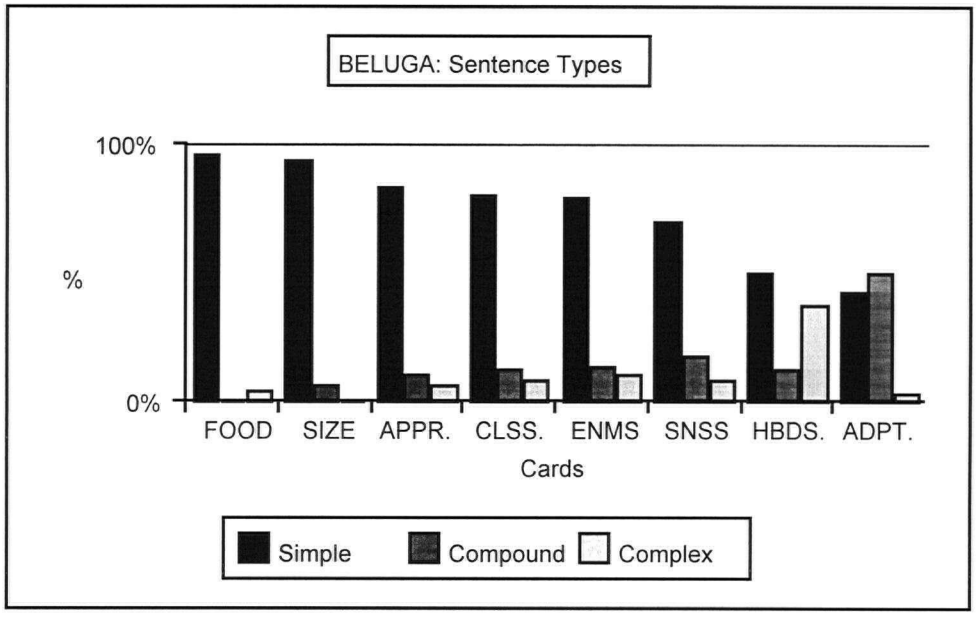
Card	Graphic source sentence topics	Examples
Appearance	- other body parts or features - location of body parts - function of body parts	"They are white colour." "Belugas have thier blowhole on top of thier head." "Beluga whales use the flukes to swim."
Senses	- senses not included in Notebook	"Belugas can see in the water."
Size	- additional comparisons based on visual	"Belugas are bigger than a human." "belugas are taller than a human."
Classification	- reference to other classes shown on tree	"Belugas are living things and mammal." "Belugas are marine mammals."
Adaptations	- reference to a beluga whales' breathing sequence	"First they swim to the near top of the water, then they open their blowhole."

It is clear that the students were able and willing to use the graphics as a writing resource in completing their Beluga Stack card tasks and it is also clear that the limited amount of use they made of this support is related to both the quality of the visual information and to the availability of competing supports. Changes in card design for the Marine Mammals portion of the project will also be reviewed in light of these observations.

Sentence Types

Looking at basic sentence types provided another way of comparing student texts to variables in the task environment. The following chart tracks the proportion of simple, compound and complex sentences in the students' own writing excluding those sentences classified as copied. The percentages are calculated against the number of reconstructed and original sentences written for each card rather than total number of sentences per card. The intention is to show more clearly the ratio of sentence types to the students' own writing. The definitions for the three types are roughly based on traditional English grammar without going into details of the kinds of connectives, conjunctions or related types such as compound/complex. The card order follows the ratio of simple sentences from greatest to least.

Figure 3.5 - Beluga Stack Sentence Types



Three general trends appear clearly in the graph First, simple sentences are the major type in seven of the eight cards with Adaptations being the exception. Second, simple sentences vary inversely with both compound and complex sentences. Third, complex sentences are the least common type overall and are a significant on only the Habitat & Distribution card.

The Adaptations card appears as an anomaly in two ways. First, there is an unusually high number of compound sentences, and second, these sentences are the most common type for this card. The likely explanation for this situation is the instructor's lesson on comparative and sequence language that accompanied the introduction to the card. Students were shown the use of words such as 'first, second, next, last, then' to describe steps in a sequence. A survey of the sentences on this card shows that all students included this textual language throughout the card's sentences and that they frequently created longer compound sentences using either 'and' or 'then'. For example, "The second step is they open the blowhole the air comes out, then they jump up and take a breath" and, "They swim at the top of the water and they open their blowhole and their air come up of the surface". The teacher/librarian also reminded students of the use of the word 'but' which was introduced

previously in the Notebook of the Senses card. This resulted in sentences such as the following which was reconstructed from Notebook text, "Belugas can stay water about 3 to 5 minutes but, People can stay about 1 minute". Most of the students used 'but' to compare beluga and human diving yet most of those sentences were copied without other modification from the Notebook's sentence frames and therefore don't appear in this tally of original and reconstructed sentence types.

Six other cards contain predominantly simple sentences with far fewer complex or compound sentences. The simple sentences on these cards are usually more than noun plus verb statements and contained additional information and textual language. These additions came from Internet resources, from the Notebook format and from the graphic and helped the students produce more sophisticated sentences.

On the Appearance card students often rewrote the Notebook/Internet note into language they were more familiar with but which still showed their understanding of the information. The Notebook prompt about the beluga's melon read, "The melon is probably used for ...". Students completed this with "sound production" or "facilitates sound production" and then wrote more direct statements such as, "The melon use to make the sound", and, "Belugas use his melon to make sound". By maintaining the verb 'use' from the Notebook, by not copying 'facilitates' nor changing the verb to 'makes', the students have written sentences appropriate for their age and for a school animal research report. Some students rewrote the Internet note to explain the meaning of a new or difficult word. Harry completed the Pectoral Flippers note with "to steer" and expanded this in his sentence, "Beluga whales have to use their two flippers to turn right and left." This has been extracted from item four on an Internet page with five points about beluga pectoral flippers, "4. Beluga whales use their pectoral flippers mainly to steer and, with the help of the flukes, to stop." Others referred to the graphic to combine ideas and present more information. In this sentence, Larry adds information about the location of the blowhole before writing about its function, "Belugas have thier blowhole on top of thier head. Belugas blowhole used for

breathing." The last sentence is rewritten from the prompt, "A beluga whale ... through its blowhole", which Larry completed with the word "breath".

Examples of the practice of identifying a key bit of Notebook information from a large and difficult web page and then rewriting both into their own simple sentences is summarized in the following list. The 'From' column shows the Notebook prompt with the student's Internet addition underlined and the 'To' column shows the final sentence.

Table 3.8 - Beluga Simple Sentence Examples

Card	From	To
Food	WHERE near the bottom of the ocean HOW herd fish into shallow water before attacking	They get their food near the bottom of the ocean. Beluga find there food in the shallow water.
Size	Average female beluga length = 3 to 4 m	Belugas length is about 3to 4 m. Belugas are bigger than a human
Classification	-from key visual, Living Things > Vertebrates > Mammals Delphinapterus - means that belugas are dolphin without a fin	Belugas are living mammals in the ocean. belugas are vertebrates. Beluga whales don't have a fin.
Enemies	Predators (enemies): List two other animals which attack belugas. killer whale and polar bear Human Actions: • make toxic chemicals	Their enemies are killer whale and polar bear. Toxic chemicals can kill belugas and other animals.
Senses	An acute sense is one that is very good. Belugas have an acute sense of sight and hearing.	Beluga see very well under water. Human can't see very well in the water.

Four cards also contained enough examples of reconstructed or original compound and complex sentences to merit consideration. One way students created these longer sentences was to combine their own ideas and writing with a piece of text from the Notebook. On the Senses card, Helen adds an idea from the Appearance card to the end of this note, "Humans hear through their ear but belugas hear through their lower jaw", and writes this compound sentence, "Beluga don't use ear to hear like we are, they hear through their lower jar and they use the melon for producing sounds." Robert takes the 'Human Actions • make pollution' note on the Enemies card and writes, "Human makes polution and the beluga whales will get poison."

Another process for generating longer sentences was to join ideas from the key visual to information from the Notebook. "They have vertebrates, fin and is white in colour" takes the 'vertebrates' idea from the graphic and joins it with two Notebook ideas, "Delphinapterus - means that belugas are 'without a fin'; Leucas - tells you that belugas are 'white'." Interestingly, the incorrect statement about 'having a fin' is contradicted in the next sentence which the student copied from the Notebook. This student also confirmed her correct understanding of the belugas' lack of a fin in her Appearance key visual which has the belugas' dorsal ridge correctly identified and labeled. A final process for constructing long, compound or complex sentences was to join many Notebook ideas, "Human action are hunting beluga and oil exploration and make pollution to the beluga whales."

The unusually high percentage of complex sentences on the Habitat & Distribution card, thirty-eight percent, is primarily a calculation result. Although three out of forty-two sentences were identified as complex, when compared to the students' own sentences that becomes three out of eight. What is interesting is that each of the identified complex sentences appeared in reconstructed sentences where the students linked different notes together to show cause and effect. For example, James writes, "In the autumn, most belugas will move to the south of the world, because in the winter, the Arctic Ocean is very cold". He constructed this sentence from ideas and words represented in the following notes, James's additions are underlined, "Belugas live in the Arctic Ocean. Belugas live in icy waters as cold as 0-C. Most belugas migrate south in the autumn". This process of constructing a complex sentence from simple sentence notes in the Notebook was also followed by David and Helen.

The combination of language examples in the Notebook and graphic and information supports to guide Internet research has allowed this group of early ESL students to produce types of sentences appropriate to their research report task.

Textual Language

One of the teaching and learning goals was to introduce beginning ESL students to the use of textual language which would help them express more complicated concepts with more appropriate English and which would begin to move their sentence writing skills beyond

direct statements and into more abstract statements of sequence, comparison, principles, cause and effect and evaluation. To this end, the Notebook and graphic design of the HyperCard stack were seen as an interface with the Internet resources, and therefore, design elements of the project were intended to encourage students to become aware of and to use more textual language. Table 3.6 displays the percentage of textual language found in reconstructed and original student sentences and omits that which appeared in sentences the students copied more directly from the Notebook and Internet.

Figure 3.6 - Beluga Stack Textual Language

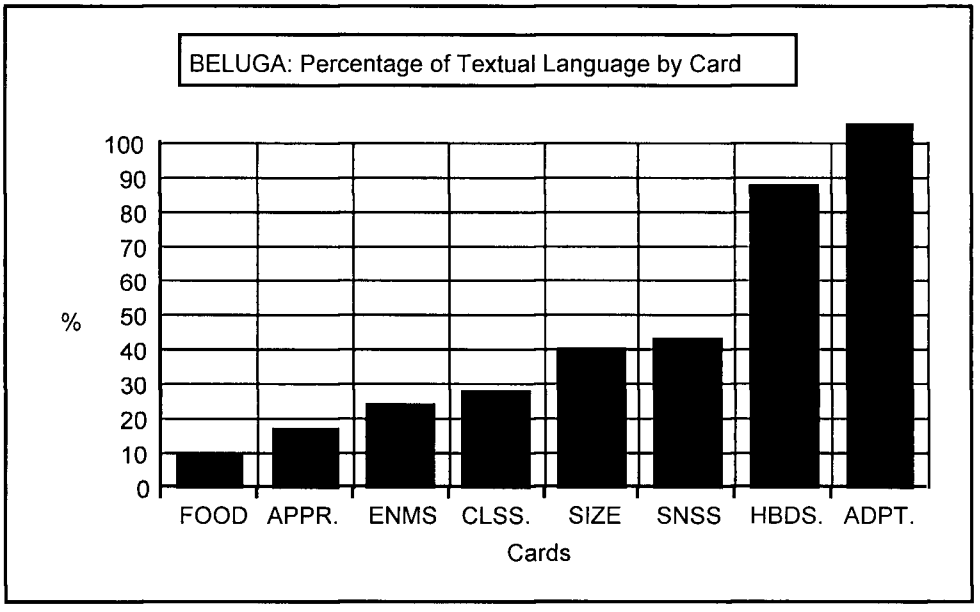


Figure 3.6 is unusual for a number of reasons. First, the figures for two cards, Habitat & Distribution and Adaptations are considerably higher than any of the other cards. Second, with the exception of those cards and the Food card, the remaining cards show that less than half of the students' sentences contained examples of textual language examples. The figures suggest that some aspects of the task situation for four of the cards encouraged students to use some textual language and equally clearly, something about the Food card discouraged this use.

Recalling the preceding analyses of the Food card which showed that most of the student's Internet notes were entered as phrases onto the graphic note fields, and, that these were then reconstructed into statements about what, where and how belugas get their food, it

is not surprising that there were few opportunities for students to employ connecting textual language in sentences which were predominantly simple statements. A similar situation seems to exist for the Appearance card in which there was no special focus or support for descriptive language or other kinds of textual language and the results are also quite low.

The high tally for the Adaptations card was also partly accounted for in earlier comments which focussed on the teacher/librarian's introduction of the language of sequence in association with the belugas' adaptations for breathing. In the case of the Adaptations card the raw score for instances is thirty-two. This is three times the average for the other cards and shows the effectiveness of direct instruction on the students' writing.

Teacher instruction and reminders to students about additional words they could use to help explain their ideas started when students were shown the second card in the stack, the Size card. When introducing a new card the instructor would show the students the Notebook and together they would review the instructions and expectations. At this point the teacher/librarian might point out additional language which could be used to convey the ideas. These mini-language lessons occasionally occurred at the end of a library period before the students came to the Internet lab and more regularly at the first lesson to introduce a new task card. The Size card results, with forty percent of the students' reconstructed or original sentences containing instances of textual language additions, suggest that these lessons and reminders were effective.

The high percentage for the Habitat and Distribution card is primarily a calculation result due to the low number of student sentences, either original or reconstructed, and the relatively high proportion of language examples in those sentences; seven instances in eight sentences. If the results for the Habitat and Distribution card are compared on the basis of raw score numbers then the instances of textual language use are virtually the same as that for the other cards excepting Food and Adaptations which remain unique.

The following short catalogue shows some of the textual language included in the Notebook or introduced by the teacher/librarian and demonstrates how it has been employed by the students in either reconstructed or original sentences.

Table 3.9 - Beluga Stack Textual Language Examples

Card	Textual language from the Notebook or introductory lesson.	Sentence examples
Classification	Notebook: belongs to, means, tells you that Teacher: is part of	"They are vertebrates and belongs to the mammals group."
Size	Notebook: times longer than, times heavier than Teacher: bigger/smaller than, more/less than, taller/shorter than	"Belugas are bigger than a human." "Beluga whales are about 3 times taller than a human."
Appearance		"Beluga whale has a melon to save them sale because the swim to the ice they are not get so hurt." "Flukes and flippers are very important for the belugas because belugas use them to swim and change the direction."
Senses	Notebook: but Teacher: similar/different	"Beluga's senses are different from humans." "Belugas have a very good of hearing than human, but they have no senses of of smell."
Habitat & Distribution		"Belugas live in the Arctic Ocean, But sometimes they are found in large rivers."
Adaptations	Teacher: but; first, second, next, last, then	"The belugas usually dive about 20 meters deep, but people usually dive can dive about 10 meters." "The third step is they go down and close the blowhole."
Enemies		"People have done to threaten belugas, for example, People hunted the belugas."

The most obvious conclusion from the above discussion, table and chart is that a significant use of textual language by early ESL students requires more than casual support. It is only on the Adaptations card where the teacher, Notebook and key visual all encouraged the students to use special language that any dramatic results are apparent.

Beluga Cards & Task Design

The goal in conducting this aggregate review of the work the students' did on the Beluga phase of the project was to identify any commonalities or anomalies in the relationship

between the students' written products, the digital working and learning environment and the interventions of the teacher. This will allow additional comparisons to be made with the aggregate data from the Marine Mammals phase of the project which was the next part of the students' work.

D. Marine Mammals Stacks Summary Data

The following tables present raw score and percentage data for the Marine Mammals phase of the research project. Each table uses the same analytical categories applied to the Beluga stage data and is a total from each completed student card. The first table presents this information as raw score data and the second converts the numbers into a percentage for that card. Again, the numbers are actual and not pro-rated according to the number of students. There is little need or justification for extrapolating from one student's writing to another's which would create a false prediction about the number or kinds of sentences an individual child might write. The percentages provide some equivalency between the various tasks since the number of sentences written for each card in the Marine Mammals stack is very similar to the Beluga stack amounts. Thus comparisons of sentence construction, types, sources and textual language are based on equivalent data sets. The overall totals are less than those for the previous section for at least two reasons. First, there were fewer task cards in the Marine Mammals generic stack, six compared to eight, and second, there was one less student. This difference is of little consequence to the analysis of sentences since the individual card comparisons are based on similar quantities.

The data on the Adaptations card is perhaps the least likely to be consistent as only four students completed the writing on this card and there were only fourteen sentences to consider. This card will be excluded from the general comparisons and will be considered separately. A brief look at the Adaptations data shows that omitting it from the subsequent tables and graphs will remove some extreme numbers since in five categories the few sentence results for this card are either one hundred or zero percent.

As in the previous division, the data results from a close reading of each part of the students' work including the Notebook, the card graphic or key visual and the set of final

sentences. The purpose of this collected data is to present an overview of the interaction between the elements of the workspace and students' final written product. The present section will follow a similar outline to the Beluga data discussion.

Table 3.10 - Marine Mammals Raw Score Data

CARDS	Class	Size	Appear	Habit/Distrib	Adapt.	Food/Enemy	Total
NOTES	76	104	119	62	23	59	443
SENTENCES							
Total	36	40	43	27	14	37	197
Copied	0	5	5	8	0	26	44
Reconstructed	0	19	32	14	14	7	86
Original	36	16	6	5	0	4	67
TYPES							
Simple	27	26	31	17	10	9	120
Compound	2	7	4	1	0	1	15
Complex	7	0	4	1	3	1	16
SOURCES							
Notebook	18	25	39	25	14	32	153
Graphic	31	17	6	1	13	19	87
TEXT. LANG.	26	37	9	17	4	2	95
ERRORS	19	36	35	29	31	47	197
STUDENTS	10	10	10	8	4	10	

Notes, Totals and Errors

General comments made previously about overall totals and sentence totals in particular also apply to the Notes tally which gives a rough guide to the workload expectations and production for each card. For the Marine Mammals work, the Notebook window's organization and expectations were standardized and made more equal. Students looked for between three and six notes or facts on the Internet and recorded these in the Notebook. They also completed different parts of the graphic tasks which were counted as part of the Notebook record. These were somewhat less equal as the higher numbers for the Classification, Size and Appearance cards show. On these three cards the students added between five and ten pieces to the graphic. These graphic tasks, with their variety of fonts, labels and images received a lot of attention from the students.

Table 3.11 - Marine Mammal Sentences Percentage Data

CARDS	Class	Size	Appear	Habit	Adapt.	Food
SENTENCES						
Total	36	40	43	27	14	37
Copied	0%	12%	12%	30%	0%	76%
Reconstructed	0%	48%	74%	52%	100%	14%
Original	100%	40%	14%	19%	0%	11%
TYPES						
Simple	75%	74%	82%	89%	71%	82%
Compound	6%	20%	11%	5%	0%	9%
Complex	19%	0%	11%	5%	21%	9%
SOURCES:						
Notebook	50%	62%	91%	93%	100%	86%
Graphic	86%	42%	14%	4%	93%	51%
TEXT. LANG.	72%	106%	24%	89%	29%	9%

The error percentage for the Marine Mammals sentences is considerably higher than that of the Beluga sentences for only one card, Adaptations. As mentioned earlier, the Adaptations card is a special case because it was completed by only four of ten students and coincidentally, by the some of the weakest English language students in the group. The other cards show a very similar range of amounts and types of errors as found in the Beluga cards. Considering the short duration and overall similarity of the two parts of the project this is to be expected; it would have been much more surprising to find a marked difference in the correctness of the sentences.

The quantity and frequency of the errors was a concern expressed to the researcher by the classroom teacher who hoped that the students' final products would show more correct English. Unfortunately, given the very short duration of the whole research side of the project, time for any final and even ongoing review and correction with the students was very limited. This diminished the teaching and learning opportunities for the students and highlights the degree to which this work environment closely resembles mainstream classroom expectations where students have to correct and improve their writing throughout the writing process rather than leave it to an end-of-project task. From the point of view of

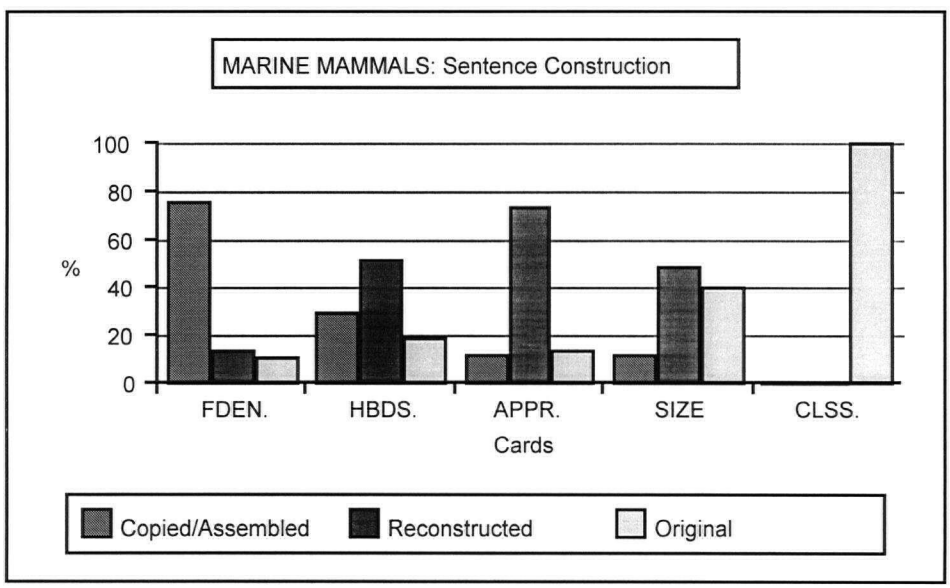
practicing teachers, the seemingly high ratio of errors to sentences is likely a disincentive to challenging ESL students with this kind of research project. It is conversely, one of the incentives to understanding better how ESL students' language and content skills and understanding can be supported and improved within this kind of a mainstream classroom project.

Student Sentences

Sentence Construction

Figure 3.7 summarizes the percentage results by card for each sentence construction process. There is a clear inverse relationship between copied sentences and the other two categories, reconstructed and original. This is partly derived from the opposing definitions but also indicates that students have usually preferred one form of sentence construction over another and have not been inclined or encouraged by the task environment to use each type equally. A better understanding of the differences and similarities between the cards is part of what is of interest here.

Figure 3.7 - Marine Mammals Sentence Construction



Following this interest, it is notable that the Food and Enemies card has generated a high proportion of copied sentences. Characteristics of the card are unique within the Marine

Mammals set for four reasons. First, it was the only card where the Notebook format did not get changed to simple notes from the sentence-like notes common in the Beluga cards. Second, it combined topics from two cards of the previous set, Food & Young and Age & Enemies. Third, the graphic element was new in two ways, it looked very different from any of the cards the students had worked with before, having two opposing triangular note frames, and finally, these note frames required students to use the graphic text tool rather than the word processor to enter their on-screen notes. Examining the students' sentences it is very clear that they have chosen to build their sentences from the Notebook rather than from the screen-based notes. Their sentences are primarily combinations of the sentence-like note taking prompts and the Internet notes which they recorded. The first line in the Notebook began with the prompt, "Look for information to tell you • what food it likes..." Students completed this prompt according to the animal they were researching by adding phrases such as, "tiny animals tubeworms" or "squid, crabs, shrimps and fish". They proceeded by copying the two parts from their notebook and assembling them into sentences such as, "The Narwhal like to eat a squid, crabs, shrimps and fish" and "The grey whale like to eat tiny animals like tubeworms." The predominance of this form of copied sentence suggests that students found the Notebook language resources more inviting than the single word notes they transcribed onto the screen triangles. This preference does not appear to be based on the computer's ability to copy and paste text directly from the Notebook into their text field since many spelling, plural and verb errors appear in their transcriptions which would not have resulted if they had copied the text electronically. This observation, contrasting sentences built from copied parts to sentences built from single word lists, is not evaluative, there are many reasons and situations in which a teacher might wish to encourage students to follow one process or the other. On the other hand, it does point out the degree to which variations in an electronic task environment can influence the language learning process.

Considering the three cards represented in the middle of the graph, it would seem that the Appearance card design promoted a more extensive reworking of Internet/Notebook data such that the sentences were coded as reconstructed rather than copied. Reviewing the

students' Notebook records, it appears that the student pairs have adopted one of two approaches for recording information into the Notebook. Two pairs entered short notes, usually between one and five words and representing two or three phrases, whereas, three pairs entered longer notes which might contain as many as a dozen phrases. The students who kept their notes short then reconstructed them into sentences by adding a noun and verb to the recorded notes. Students who found and copied much more information from the Net naturally tended to write more but followed the same process of following a noun/verb introduction with one or two segments from the notes. In both approaches the students had to do more independent writing on this card than on the Appearance card since there were no sentence-ready segments built into the Notebook design. This situation is true for all of the Marine Mammals cards in contrast to six of the Beluga cards which presented more sentence-ready notes in the Notebook.

The design change was implemented by the researcher in response to the teacher/librarian's observations and comments regarding the contrast between the library unit's notetaking strategies and also regarding the students' Internet research. He observed that students were having difficulty copying appropriate chunks of information from the Internet. In his written comments included in Chapter 2 he expresses these concerns. He states that, "if the student had copied sentences or more than just key words from sentences and pasted these into the template, writing was not as successful." He further comments, "Rather than "take notes" there was a tendency with some students to copy and paste sentences, or parts of sentences which contained more than just key words. This later affected the quality of their writing." The ideas behind the Notebook redesign were discussed with the classroom teacher and teacher/librarian and implemented with the thought that students would be better able to accomplish three parts of their research task: 1) identifying the key information in the Internet resource by attending to the Notebook prompts then carefully reading the resource; 2) copying only the critical bits of information; 3) showing their content understanding by rewriting the information.

The modification of the Appearance card's Notebook seems to have affected at least two parts of students' research task. They have successfully focussed on identifying and copying key information. Even the longer notes favoured by some pairs are built up from shorter notes which they collected from Internet resources. The following single line polar bear note by James exemplifies the degree to which some students became adept at gathering information bits: "nose is broad and black. Tail is small. Have 42 teeth. eyes are dark and brown. ears are small and rounded. skin is black". In this case, he has successfully read at large segments of the Internet resource to have identified this information. The students' rewritten sentences based on these notes certainly show a satisfactory level of content understanding although the depth of this understanding is not apparent in the text alone.

The Classification card completes the Sentence Construction graph with an unusual, one hundred percent tally of original sentences. Re-examining the cards and the Notebook confirms this result as the short Internet/Notebook notes did not provide the students with many options other than to write their own sentences. Each of the students recorded the three scientific names describing their animal's order, family, genus and species for a total of thirty entries, but, only five entries included the meaning of the Latin words. While finding meanings for Latin words had been an easy task for the Beluga whale it proved to be much more difficult for the variety of animals the students studied at this point. Hence, their Internet notes were very minimal and so students used both the key visual and the classification word bank to help them write complete sentences. The following example reconstructs this process and suggests how the design elements interact.

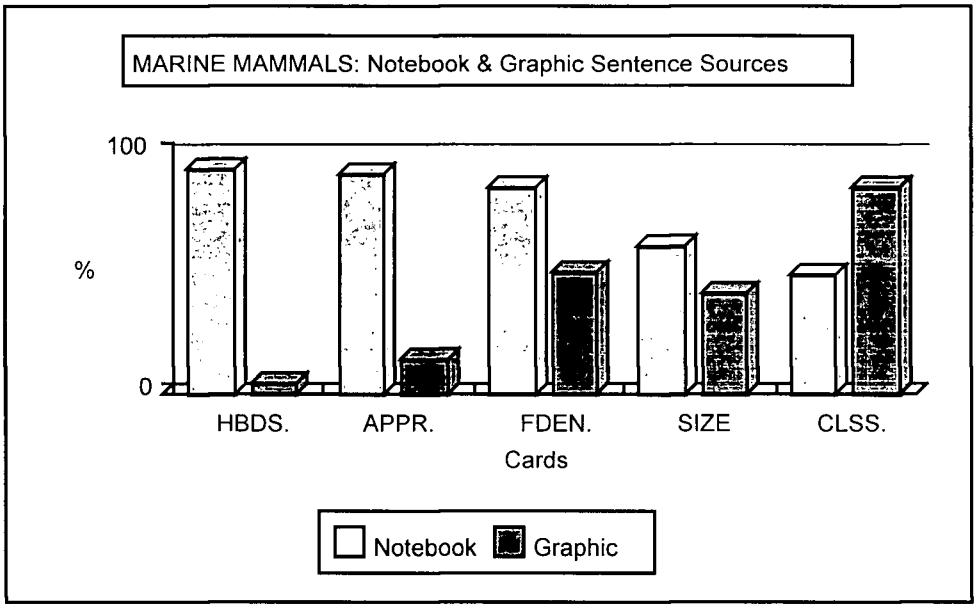
Robert and Michael were able to discover the family name and meaning for the Narwhal. Robert recorded this as "monodontinae = TOOTH WHALES = ONE TUSK". He then wrote the following two sentences combining resource information from all parts of the work space. In the Notebook he found the order, 'cetacea' and the family name as just quoted. On the the key visual he had marked mammals, vertebrates and living things and lastly, from the word bank, he took 'belong to' and 'means'. His sentences read, "Narwhals are mammals and vertebrates and living things. Narwhals belong to the order cetacea and

their family is called monodntinae which means they have one tusk." He even included a spelling error. It is clear in this example that the combination of support elements in the Classification task card influenced the students to write their own sentences.

Sentence Sources

Notebook and Graphic sources were identified as another way to describe the students' writing process within this computer environment. Both scorings have been combined in the following graph.

Figure 3.8 - Marine Mammals Sentence Sources



While, the inverse relationship between the two categories is very clear as it was for the Beluga products, there is an increase in sentences derived from the graphic. The graph conceals one difference between the two card sets. Since the categories are not necessarily exclusive and the percentage total can be greater than one hundred. Among the Beluga cards this only occurred in the Appearance card's results which totalled one hundred three percent; most of the other cards equalled exactly one hundred percent. The totals for the Marine Mammals cards are listed below with the Notebook figure first.

Table 3.12 - Marine Mammals Notebook Plus Graphic Sources

Habitat & Dist.	Appearance	Food & Enemies	Size	Classification
93 + 4 = 97%	91 + 14 = 105 %	86 + 51 = 137%	62 + 42 = 104%	50 + 86 = 136%

The overall totals are higher for the Marine Mammals cards indicating that the final sentences contain information that could have come from either or both sources. Sentence examples of overlapping sources are listed below. The additions the students made to the Notebook and Graphic are underlined to indicate the separation from the material that was already part of the card.

Table 3.13 - Marine Mammals Combined Source Sentences

Card	Notebook	Graphic	Sentence
Class.	• Order = Pinnipedia = "fin foot"	Pinnipedia fin foot	"They can use their fin foot to walk and swim."
Appear.	• special parts = fippers	line drawn to flipper on a standing Sea Lion	"They use their fippers to swim and walk."
Size	• Average female weight between 1,361-3,629kg	- scale with 1 Killer Whale balancing 34 humans	"The average weight of the killer whales (female) is between 1,367-3,629kg, but the human is lighter."
Adpt.	• Thermoregulation (Body Heat) = grey whale caverd with thick skine	Keeping Warm - they thick blubber	"Grey Whale can keep warm becouse they have thick blubber."
FdEn.	• who its enemies are = killer whales, sharks	Enemies – Killer whales Sharks	"Sea Lion enemies are killer whales and sharks."

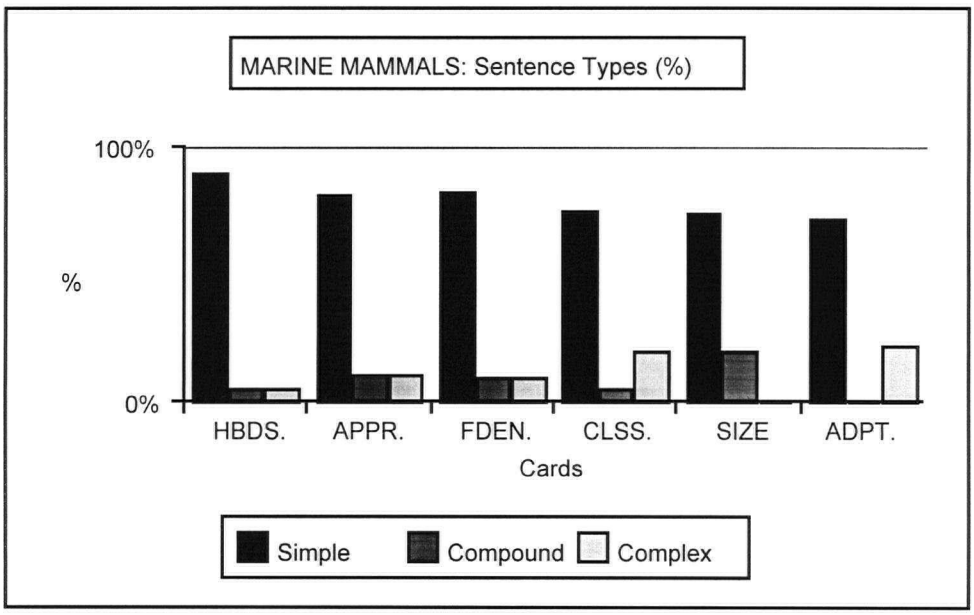
Sentences drawn from both sources sometimes show an interesting combination of ideas. The example sentence for the Size card takes the numerical facts from the Notebook but then appends the comparison with humans which appears to have come from the graphic. The first example from a Classification and an Appearance card by the same student shows how students have been able to connect information from different HyperCard cards. Suzy learned about 'fin foot' when working on the Classification card. When she completed the Appearance card she was able to mark the 'fipper' and included in her sentence the

information about swimming and walking she had previously learned. She did this even though the Appearance card image she collected shows a standing rather than a swimming Sea Lion. Combining information from various cards and from both Notebook and Graphic sources was quite common throughout the project but particularly so in the Marine Mammals part. This may be related to the changed information gathering process where the students no longer worked sequentially through the cards but had to take information from the Internet pages and decide where it belonged in their HyperCard stack and were thus required to work with information on the animal in a more comprehensive, less fragmented, manner.

Sentence Types

Figure 3.9 places all three sentence types, simple, complex and compound, on one graph showing both the relative proportions of each type in the students' original and reconstructed sentences and also the relationship between the types. The card order follows a decreasing percentage of simple sentences.

Figure 3.9 - Marine Mammals Sentence Types



As with the Beluga results, simple sentences are clearly the predominant type in all cards. These sentences often include compound predicates or subjects as well as textual language and prepositional phrases which convey more information and help to give the text a

more academic tone. The following table includes examples of 'stretched' simple sentences from each card.

Table 3.14 - Marine Mammals Simple Sentence Examples

Habitat & Distribution	About 21,000 to 28,000 polar bears are in the world now. Polar bear live in the deep and cold water.
Appearance	Polar bear is covering by white and smooth fur. They are very heavy and have a long neck.
Food & Enemies	Humans and pollution are enemies of polar bears. Humans sometimes catch killer whales to perform in the aquarium. The grey whale like to eat tiny animals like tubeworms.
Classification	They are vertebrates and belongs to the mammals family. Narwhals are mammals and vertebrates and living things. Killer whales is kind of grouped marine mammals.
Size	Grey whale is 5 times heavier than a human It will takes 13 people to weight as much as a narwhal. A sea lion is taller than a human by about 1.0 m.
Adaptations	Grey whale move with their flipper and tail fin. Narwhals use his blubber to protect him or her in cold.

The small additions which the students have made to these simple sentences come not only from their own knowledge and writing abilities but also from an effective use of the computer writing environment. Some additions come from combining different Internet notes or from linking a note with the Notebook words. Combinations in the above table include, 'very heavy and have a long neck', 'white and smooth fur', 'mammals and vertebrates and living things', 'flipper and tail fin'. Other additions come from the Notebook's word lists: belong to; is a kind of; heavier than; as much as; taller than.

The Size card is unusual in that there were seven compound sentences and no complex sentences. Most of these compound sentences were counted as reconstructed as they were created by joining two or more Notebook notes. In this sentence, Michael links notes on human and narwhal weights, "An average female human weight is 73 kilograms but an average narwhal weight is about 0.8 - 1.6 tonnes." Some of the compound sentences came directly from the size graph and the weight balance key visuals, "Grey whales are about 3.5 m taller than a human and grey whales are 5 times heavier than a human."

The Classification and Appearance cards have examples of both compound and complex sentences. In this example, James uses 'member of' from the word list to put the note, 'Family = Ursidae' into a complex sentence, "Polar bears are the members of that family called ursidea." Robert follows the same route, "Narwhals belong to the order cetacea and their family is called monodntinae which means they have one tusk." Compound sentences on the Classification card usually combined the introductory parts of the key visual to make a long sentence, "Killer Whales belong to living things, they are mammals and they have vertebrates." James uses the same process but draws the information from his Internet notes, "Their body are long and they has long neck." On his appearance card, Michael uses 'but' to make a contrast, "The special part of the narwhals is other whales have dorsal fins but narwhals don't have dorsal fins."

The collection of examples reviewed in this section point to the various ways the students have successfully used elements of the card's design to convey their understanding about the animals in language appropriate to the task and language that is similar to that used by mainstreamed students.

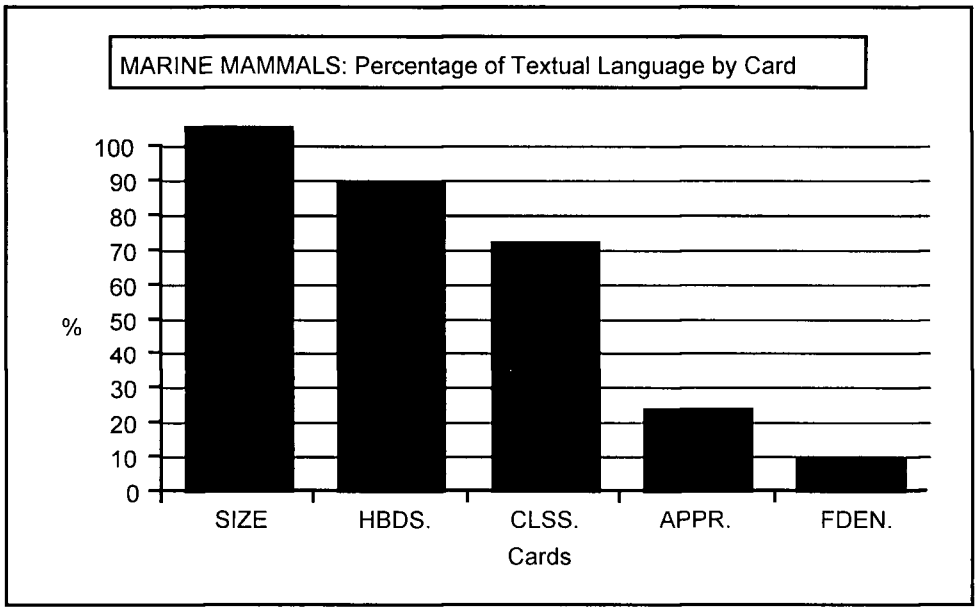
4. Textual Language

The modifications to the Marine Mammals stack put examples of textual language into each card's Notebook to help standardize the format and to encourage more consistency in the instruction and application of these word lists. The following numbers are tallies of the use of this textual language in the students' sentences. If the language was already included in Notebook/Internet text it was not counted here. Instead, the tally looked for language that the students added to the notes to help construct their sentences. The following table compares raw score and percentage data for the Marine Mammals sets and the graph summarizes these results by card.

Table 3.15 - Marine Mammals Textual Language Data

MARINE M.	Class	Size	Appear	Habit.	Adapt.	Food
# of Instances	26	37	9	17	4	2
Percent	72%	106%	24%	89%	29%	9%

Figure 3.10 - Marine Mammals Textual Language



The general results and the comparison with the Beluga cards need to be considered with a few points in mind. First, this was not an experimental situation with controlled variables; factors such as student partners, task familiarity, instruction and time were all subject to change between the first and second phases of the project. Second, the intent is to highlight possible interactions between the students and the task environment which may have contributed to the observed changes in their writing. The discussion which follows tries to focus on this interaction and to make observations within the limitations mentioned.

Beginning with the lowest results first, the students' sentences on the Food & Enemies card were almost entirely lacking in the kinds of language or sentences which would have been included in this count. Two instances out of eleven sentences were recorded. The unique aspects of the card, discussed in detail in the previous Sentence Construction section, and particularly, the sentence-style Notebook, seem likely to have influenced this result. This Notebook form enabled the majority of sentences to be built by copying. The seventy-six percent copied tally is more than twice that of any other Marine Mammal card. In combining the Notebook prompt and the Internet note into a copied sentence there was little need or incentive to use additional words such as those listed in the 'Words for Description' part of the

Notebook. Thus, despite the instructor's encouragement to check the word list to see if any might be useful, eight of the ten students avoided including any of these phrases.

Nevertheless, the two examples which were recorded offer the interesting possibility of having been included to meet the teacher's request to check the list. Helen is writing about killer whales. Her Notebook note on enemies states, "• who its enemies is = humans", although she has changed the original verb tense in the note, she corrects the verb and writes the following three sentence paragraph. "Killer whales enemies are humans. Humans sometimes catch killer whales to perform in the aquarium. Killer whales doesn't like it because it is not their real home and the place is so small." The first two sentences are typical for this card and have equivalent sentences on her partner's card, but the third sentence, the judgement, is quite unusual and entirely original. It is very appropriate, but the fact that she has included it invites the speculation that it may have been written precisely to use the keyword 'because' which was part of the card's word bank and because the instructions which introduced each word bank said, "Use some of these words in your good sentences."

James also includes one of the word bank words, 'always', in his sentence, "Humans always use snowmobiles, boats, and airplanes to hunt polar bears." 'Always' is not included in the Internet note which this sentence is copied from and it is an unnecessary addition. Again, this suggests that it may have been included to 'meet the teacher's expectations' but in this case it is not such a successful inclusion.

The other Marine Mammals cards showed a much higher use of textual language than either the Food & Enemies or than most of the Beluga cards. The following three tables contain the word bank from each card and a selection of example sentences.

Example 1 appears to be another example of a student's use of the word bank for the sake of using it regardless of accuracy, and perhaps regardless of comprehension, since grey whales, unlike humpbacks, are not both smooth and rough. This possibility is reinforced since there is a Notebook reference to "thick skine" but not to 'smooth and rough' skin. Sentences 2 and 3 are from partners and show two interesting points. First, both students use

Table 3.16 - Appearance Card Textual Language

Appearance Notebook Word Bank	Example Sentences
used for; on top; on the bottom; at the front; at the back; along the sides; smooth; rough; covered with; shaped like; light, dark (colour)	1. The grey whale are very smooth and rough. 2. A killer whale has four special parts, for example ... 3. Killer whales have three special parts (1) the Killer Whales' colours are black above and white colour on the bottom ... It has a tall triangular dorsal fin at the back and has large flippers on the side ... another note about ... 4. Narwhals are coverd with a thick skin. 5. Polar bears are covered with white fur.

a similar introduction and include the phrases "for example" and "another note about". These were were not in the Notebook although they had been part of at least one of the instructor's mini-lessons and may have been part of a 'teachable moment' between the teacher/librarian and the partners. Second, sentence 3 shows how only one of the partners has continued to include other phrases in her sentences and has applied them correctly. Sentences 4 and 5 are show how students were able to use the word bank to alter the Notebook's Internet prompt from "• body covering = " to "covered with".

Table 3.17 - Habitat & Distribution Card Textual Language

Habitat & Distribution Notebook Word Bank	Example Sentences
is found in; likes to live in; prefers; is often; usually; always; during the winter/summer/spring/fall;	1. Grey whale are found near ...In winter they are back in the alaska. 2. Gray whale lives around the world. 3. About 21,000 to 28,000 polar bears are in the world now. 4. Killer whales live along the north west coast ...

Sentence 1 is a good example of word bank usage which was common on the Habitat & Distribution card. Many students added 'found' and 'in' the appropriate season to their sentences which in part accounts for the higher ratio of textual language use on this card compared to the rate on the Appearance card. Example 2 is interesting since it may be a direct copy from the Notebook definition, "Distribution tells you where it lives around the world."

It is also perfectly matched to the student's map which shows grey whale habitats and migration on the west coast of North America and on the east coast of Asia. Sentence 3 uses 'about' which was emphasized by the teacher/librarian in earlier lessons on the Beluga Size card as a useful word to use when writing approximate numbers. It appears to be a deliberate choice by the student since his Notebook note uses a different word, "Population tells you how many animals are living around the world. •Population = between 21,000 and 28,000.".

Table 3.18 - Classification Card Textual Language

Classification Notebook Word Bank	Example Sentences
is a kind of; belongs to; is grouped with; is a member of; means; tells you that;	1. They are vertebrates and belongs to the mammals. 2. Carnivora means meat eaters. ... Polar bears are the members of that family called ursidea. 3. Grey whale are a kind of mammal.

Unlike the Habitat & Distribution card which contained additional language examples in the Notebook's definitions for habitat, distribution, migration and population, the Classification card had minimal, single word notetaking prompts. Despite this, there were at least twenty-six examples of textual language use, at least one by each student. Fewer examples have been given only because most of the students used the same set of words. In all cases, the words used are correctly applied and never appear to be gratuitous.

Table 3.19 - Size Card Textual Language

Size Notebook Word Bank	Example Sentences
longer; shorter; smaller; larger; heavier; lighter; is ... times larger than ...; is ... times taller than ...; is ... times heavier than ...	1. Grey whale is about 5m, but, human is about 1m. Grey whale is five times heavier than a human. 2. The average weight ... but the human is lighter. The female killer whales average height is ... but human is shorter. 3. A narwhal is three times taller than a person.

The Size card contained the greatest number of examples, eleven more instances than the Classification card. These examples are common to all the students' cards and are once again based on a Notebook design which had no additional sentence frames, definitions or

other examples for the students to draw on. As was also true for the Classification card, the Internet notes the students entered were very short and restricted to recording the important numerical information. Example 1 shows an interesting transformation from the Notebook to the key visual. The student recorded the grey whale's length as "40 feet" and the expectation was that all figures be converted to meters. The conversion is incorrect, but more importantly for this discussion, it is not recorded in the Notebook but is represented on the key visual where the student has carefully scaled the drawing of the whale to match the scale they labeled to a maximum of 5 m. The sentence therefore is drawn directly from the graphic and refers to both the whale and the human figure and correctly uses 'but' to make the comparison. Example 2 is interesting as it correctly uses words from the list which were not commonly used by other students. Most students used the 'heavier than/taller than' models. This suggests that using short, non-sentence form notes and including a variety of appropriate options in the language bank is one possible way to increasing choices and opportunities for students to use more appropriate textual and academic language.

The collection of examples included in the above tables illustrate the variety of ways in which students are able to make use of the word bank feature included in the revised Marine Mammals Notebook. A more further examination of the work of selected student pairs will explore in more detail the interaction between this computer research and writing environment and student language and content learning.

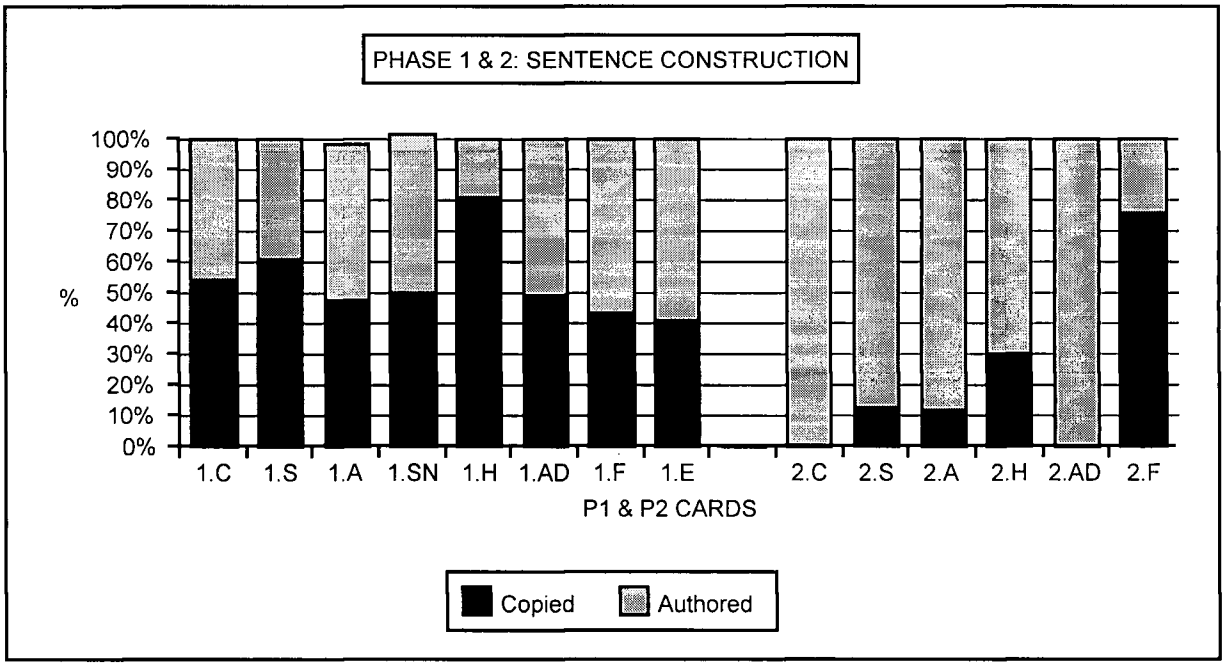
E. Summary of Aggregate Data Analysis

The task environment evolved over the two phases of the project in response to teacher observations of student work. Classroom teacher and teacher/librarian observations about inconsistencies in the presentation of writing supports and about student difficulties in recording and writing in the first phase led to revisions in the card design. The main changes were in the Notebook which was modified to include a consistent set of Notes, Words and Drawing Instructions. The Notes sections were changed to reduce the amount of sentence-type note frames and the Words section was included on all cards to provide the teachers and students with a reference set of possible language choices. The change to the Notes format

was omitted on one card, and other changes occurred in the graphic task on two cards, yet four of the cards in the second, Marine Mammals phase, remained directly comparable to the cards from the first, Beluga, phase of the project.

The analysis of the students' work presented in the previous sections of this chapter revealed variations in student discourse related to various parts of the task environment. To provide a graphical summary, the complete set of task cards from both phases of the student project were reviewed and compared by the main analytical categories of sentence construction, type, source and textual language. Comments on these graphic representations of the aggregate data follow each figure.

Figure 3.11 - Phase 1 & 2 Sentence Construction



KEY P1 & P2	CARD TITLE
C	Classification
S	Size
A	Appearance
SN (P1 only)	Senses
H	Habitat & Distribution
AD	Adaptations
F	Food
E	Enemies

For simplicity and clarity, Figure 3.11 combines the categories of Reconstructed and Original sentences as a single category: Authored sentences. This combined category is consistent with the data for the sentence Type and Textual Language categories and highlights the ratio of the students own sentences and language choices over the two phases. For all but one second Phase task, the Food card, the graph shows a large increase in student authored sentences in the generic research phase of the project and a decline in the proportion of copied sentences. This was a specific teaching objective of the classroom teacher and teacher/librarian and the graph shows the degree to which the changes in the task environment for the Marine Mammals' cards influenced the process the students' followed to construct their sentences. As discussed previously, the increase in the proportion of student authored sentences relates to an increased reliance on point form notes and key visual graphics which required the students to write their own sentences incorporating language from their notes and the word bank and referring to the key visual. The increase in graphic reference sentences is further detailed in Figure 3.13.

Figure 3.12 - Phase 1 & 2 Sentence Types

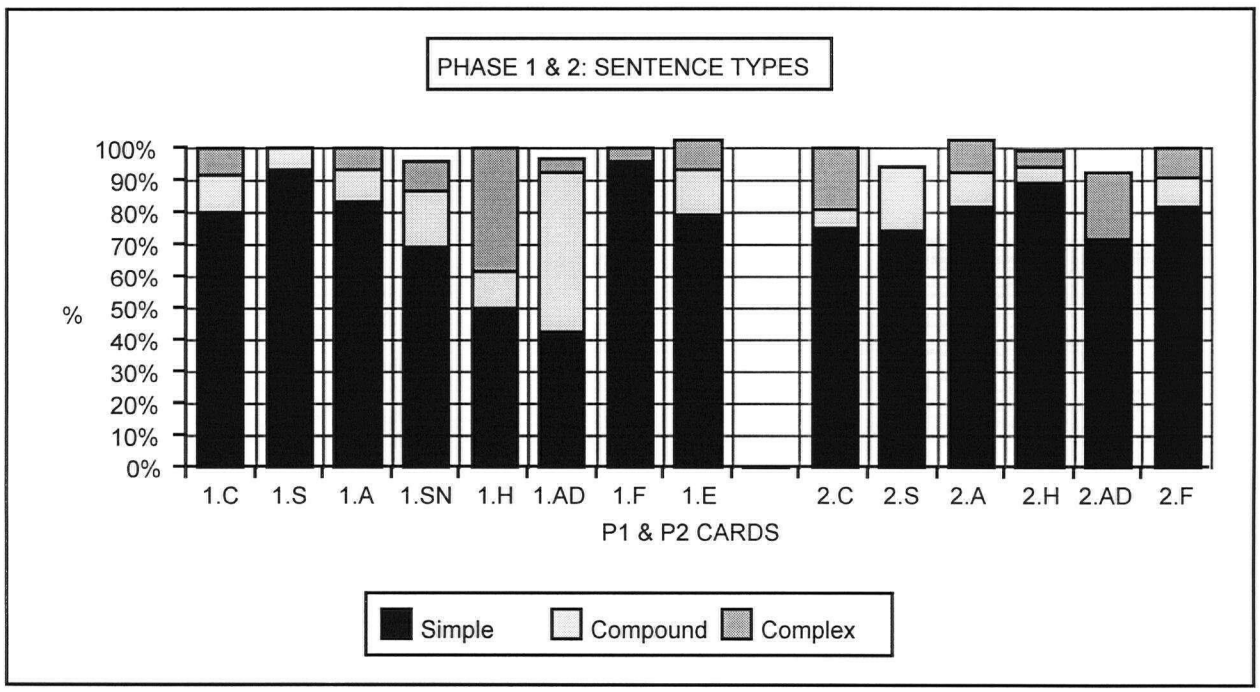


Figure 3.12 shows the percentages of simple, compound and complex sentences over the two phases. The predominance and consistency of simple sentences in both phases is clearly shown. In the first phase, simple sentences average seventy-nine percent compared to seventy-four percent in phase two. Given the early Intermediate level of the ESL students and the lack of any specific teaching objective related to sentence types it is not surprising that there is a high proportion of simple sentences and relatively little change between the two task phases.

However, it is also clear that there is greater consistency in the relative proportions of sentence types on the second phase tasks. This consistency can likely be attributed to the standardized presentation of the second phase cards or, from the other point-of-view, to variations in the presentation of the first card set. The two cards in the first phase which show unusually high percentages of compound and complex sentences, Habitat & Distribution and Adaptations, bear recalling earlier discussions. In these discussions it was pointed out that the Adaptations results relate to a unique teaching lesson on language of sequence and comparison and the Habitat and Distribution results relate to the calculation of ratios. In this case, the number of Authored sentences was very low and the number of compound and complex sentences was average such that the result is an apparently high ratio of compound and complex to authored sentences.

Figure 3.13 shows a general increase in the use of Graphic sources for sentence information for most of the second phase cards. This change would seem to relate to the reduced amount of sentence style supports in the Notebook which inclined the students to make greater use of the graphic as a content resource. The amount of Notebook reference remains approximately constant at an average of eighty and eighty-four percent over the second and first phases. As was suggested earlier, this is not a contradiction of the increase in phase two graphic results but rather a reflection of a greater overlap between graphic and Notebook content in the second phase and hence an increase in sentences coded as derived from both sources.

Figure 3.13 - Phase 1 & 2 Sentence Source

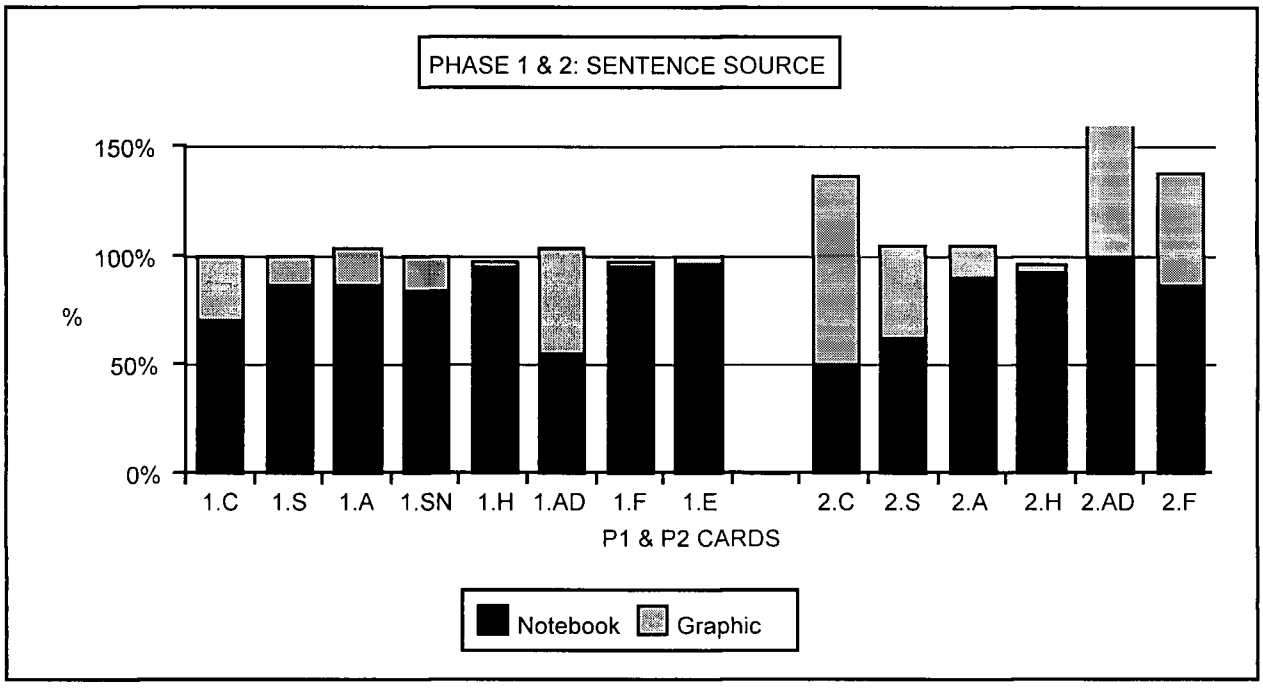
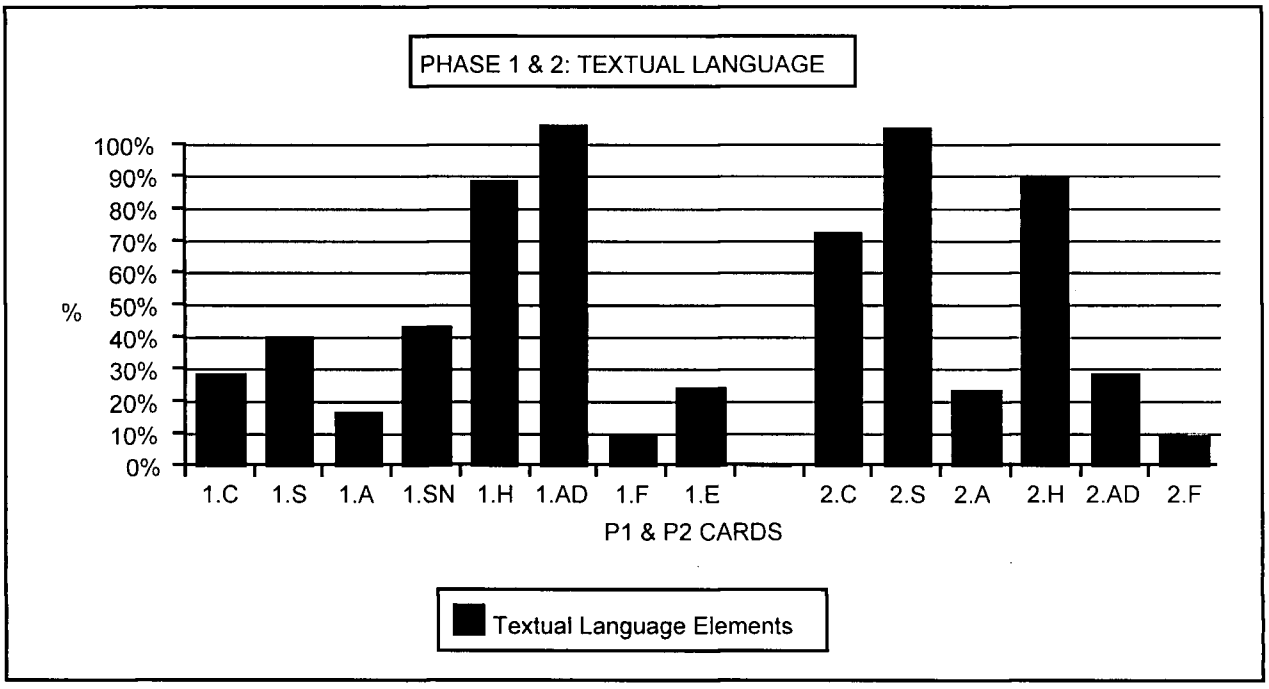


Figure 3.14 - Phase 1 & 2 Textual Language



Textual language results, as summarized in Figure 3.14, are interesting for the variety they show rather than for any simple trends. In both phases of the project, student use of

textual language elements in their own sentences varied considerably from card to card. Some discussion of these results has been recorded earlier in the chapter and showed that the interaction of writing resources influenced the students' use of textual language elements. That is, when the instructional design included access to a textual language bank, to note-style notes and a key visual graphic, student textual language use increased. In general, despite the uniqueness of some of the cards, there is an overall increase in the average percent of textual language use in the second phase compared to the first phase of fifty-five percent compared to forty-five percent. This modest change could be attributable to a number of factors in addition to changes in the digital environment including such things as increased student familiarity with the tasks and changes in resource information. The following comments compare the observed changes in the textual results to known modifications in the task environment.

Previous comments on the two Beluga phase cards with high textual language results argued that these results were unusual and related to either a specific teaching lesson on language features, for the Adaptations card, or to a ratio resulting from an average number of textual language instances compared to an unusually small number of authored sentences, for the Habitat card. While the high results for the Beluga Adaptations card are understandably linked to the teaching lesson, the lower Marine Mammals Adaptations card results are worth noting since the card modifications removed the key visual graphic. In the first version of the Adaptations card forty-nine percent of the students' authored sentences were related to the key visual graphic and used appropriate sequence language. In the second version ninety-three percent of the sentences were connected to the graphic which was a textual repetition of the Notebook notes. Although the second form of the Adaptations card was only completed by four of the children, the move from a key visual to a textual graphic was unique to this card and seems likely to account for the contrary textual language results since the graphic no longer represented concepts but was simply a place holder for text. If the second phase version of the Adaptations card had maintained the key visual format it seems reasonable to presume that the card results would be consonant with the other Marine Mammals cards.

In both phases the Food cards showed few examples of additional textual language. In the case of the Beluga card this seems to relate to the fact that the Food card was the first in the series to replace the key visual graphic with categorized text fields and to abandon the Notebook resource entirely. The card thus supported the students in copying or reconstructing simple statements about what, where and how the belugas fed. However, with no resources pointing the way to additive or contrastive language samples, students wrote simple sentences in list rather than paragraph format. The case of the Marine Mammals Food card is also unique within its set of cards. It was the only generic card which retained the sentence style Notebook and it presented a text field graphic rather than a key visual. This combination encouraged the students to copy a very high percentage of sentences from the Notebook directly into their writing field compared to the other second phase cards (seventy-six percent vs. eleven percent) and offered no key visual support for writing.

Each of the remaining Phase 2 cards showed an increase in the use of textual language features. These four cards, Classification, Size, Appearance and Habitat & Distribution are also the most comparable between phases since they retained the same key visual design and since they received the same Notebook modifications. These modifications changed the sentence-like note frames to factual notes and added a small reference set of words to aid in sentence writing. These changes in the students' work environment changed both the process and results of their writing. In the first phase, the majority of the sentences on these cards were copied from existing texts in the Notebook. On the second phase version of these cards the majority of sentences are student authored and more consistently related to the card's key visual graphic. Unlike the second phase Adaptations card which abandoned the key visual, the maintenance of the key visual coupled with the word bank had a positive effect on the number of original sentences and on the amount of textual language elements employed.

Text Analysis Summary by Phase & Card

The complete set of student products, including Internet research notes, graphics and texts for each card, were examined and related to features of the task environment for each card The set of one hundred and thirty-seven task cards from both the Beluga and Marine

Mammals phases of the project included one thousand six hundred and ninety-two notes and sentences. The text analysis considered the students' notes, how their sentences were constructed, the information source for each sentence, the types of sentences written and textual language used. Main points from this analysis are summarized for each phase of the project.

Phase 1 - Beluga Stack

Sentence Construction & Sources

Student sentences were classified as either Copied, Reconstructed or Original and derived from either the Notebook or Graphic.

1. Copied sentences was the largest category for most cards at between forty and eighty percent of all the sentences written.
2. Copied and Reconstructed sentences occurred most commonly on cards where the Notebook contained sentence frames ready-made and available for the students to complete and copy into their final text field.
3. Original sentences occurred most frequently on cards with a key visual graphic which stood alone as an information resource without the alternative of sentence-type notes in the Notebook.
4. Notebook and Graphic sources for the sentences exhibited a simple inverse relationship: when a task card provided complete or nearly complete writing frames in the Notebook students used them for most of their sentences; when the Graphic provided additional or alternative information then students used the key visual as a writing support.

Sentence Types

Reconstructed and Original sentences were also classified as either simple, compound or complex and compared to the task environment on each card.

5. The majority of the sentence are simple statements.
6. Compound and complex sentences appeared on cards which were combined with lessons on comparative or sequence language and also on cards where students

combined resource information from both the Notebook and Graphic to create longer sentences.

Textual Language

7. Textual language use increased in task situations in which the teacher's instruction, key visual graphic and notebook support all reinforced student language choices.

Phase 2 - Marine Mammals Stack

Sentence Construction & Sources

Generic Marine Mammals cards were created from Beluga cards modified to replace ready-made sentence frames in the Notebook with point form notes. This modification was consistent on all but one card.

8. Reconstructed and Original sentences predominate and the proportion of Copied sentences declined significantly.
9. The inverse relationship between Notebook and Graphic sources is repeated.
10. The proportion of Graphic source sentences increased from an average of seventeen percent to forty-eight percent of Original and Reconstructed sentences.

Sentence Type

11. Simple sentences remained the main type.

Textual Language

12. Student use of textual language elements increased on the generic cards when writing supports were consistently available and particularly when the Notebook information was supported with a key visual graphic.

Text Analysis Summary by Card Type

To provide another view of the relationship between task environment and student texts, the cards were classified into types according to the writing supports offered in the Notebook and Graphic windows. Four types were identified according to the Notebook format containing either Sentences, Notes or Instructions and according to the Graphic

format displaying a Key Visual or a Text Frame. Table 3.20 presents this classification by type and lists the example cards.

Table 3.20 - Card Tasks by Type

TYPE	A	B	C	D
Notebook - Graphic -	Sentences Key Visual	Instructions Text Frames	Notes Key Visual	Sentences Text Frames
Examples	Beluga Stack A1 -Classification A2 - Size A3 - Appearance A4 - Senses A5 - Habitat & Distribution A6 - Adaptations	Beluga Stack B1 - Food & Young B2 - Age & Enemies	Marine Mammals C1 - Classification C2 - Size C3 - Appearance C4 - Habitat & Distribution	Marine Mammals D1 - Adaptations D2 - Food & Enemies

The following figure, 4.1, shows the percentage results for sentence construction and textual language combined on one chart. These sentence categories were included since the previous analyses identified sentence construction and textual language as the most clearly related to the changes in the task environment between phases one and two. Reviewing that data by card type rather than by phase refines the distinctions between those cards which most encouraged student authorship and student use of textual language resources.

Figure 3.15 - Sentence Construction & Textual Language by Card Type

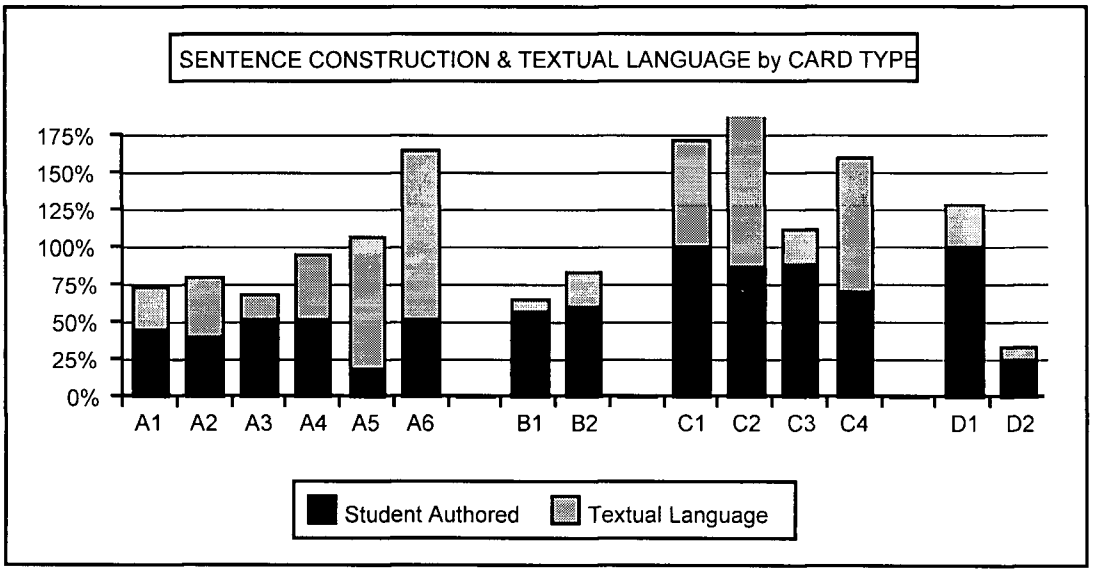


Figure 3.15 includes all of the cards from both phases of the students' work. Despite the inclusion of those cards previously identified as anomalous, the four sections on the graph show the link between the students' writing and the format of the writing supports included in the task environment of each card type. In simple terms it is clear that the Type C cards, containing point form notes and a key visual graphic, supported the students in writing their own sentences and including textual language elements to complete those sentences. The other card types containing different combinations of sentence and point form notes as well as key visual and text frame graphics did not encourage the same type of student sentence writing. If the Adaptations cards, A6 and D1, are discounted for the reasons previously discussed, then the distinction between the card types is even more plain.

Text Analysis Summary by Student

Earlier analyses have concentrated on the link between the task situation of each card and the aggregate text results. Another question is whether this link is applicable to individual students, or alternatively, whether individual student results may have unduly influenced the aggregate results. On the latter point, basic descriptive statistics may be used to compare the group of students the tasks and the textual analysis categories. The following table summarizes the data describing the aggregate student results for each phase of the students' research and for the analytical categories used in the text analysis of each task card.

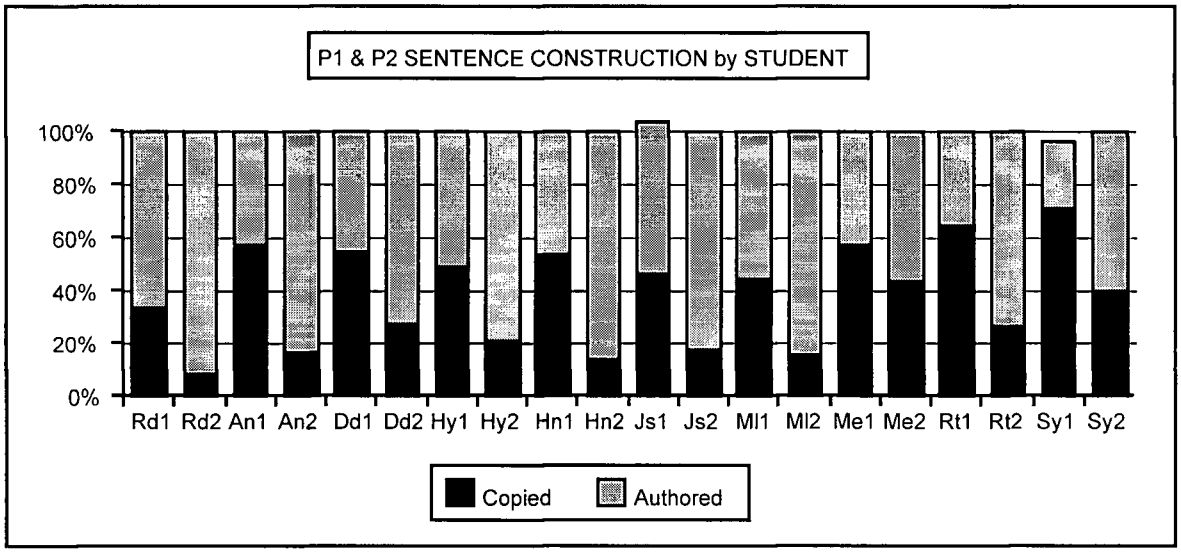
Basic questions that may asked of the data include whether the results for categories and phases are appropriate and comparable. The indicators of central tendency, mean and median, are very similar for virtually all categories and over both phases. The results are slightly positively skewed in all but four of the twenty-two lines. The indicators of variability, range and standard deviation, show a similar consistency and reinforce the conclusion that the categories and the group of students were sufficiently homogeneous to be fairly compared.

Table 3.21 - Descriptive Statistics for Analytical Category Results

PHASE 1	MEAN	MEDIAN	RANGE	SD
NOTES	61	62	16	3.90
SENTENCES	34.6	36	13	4.29
Copied	18.2	19	12	3.30
Reconstructed	7.0	6	10	3.34
Original	9.2	10	13	3.64
Simple	12.2	14	15	4.95
Compound	2.7	2	5	1.60
Complex	1.2	1	4	1.21
Notebook	28.5	29	11	3.20
Graphic	6.2	7	8	2.37
Textual Lang.	6.9	7	12	3.50
PHASE 2	MEAN	MEDIAN	RANGE	SD
NOTES	44.3	46	22	6.98
SENTENCES	19.7	23	10	5.00
Copied	4.4	4	0	2.05
Reconstructed	8.6	13	8	4.07
Original	6.7	6	2	1.41
Simple	12	14	7	4.42
Compound	1.5	2	2	1.43
Complex	1.6	3	1	0.91
Notebook	15.3	21	8	4.1
Graphic	8.7	8	3	2.57
Textual Lang.	9.5	11	8	3.23

The second question then is whether or not the observed differences between cards, phases and task types applied equally to each student as evidenced in their written texts. The following charts repeat some of the previous comparisons of sentence construction, source and textual language with individual student results over both task phases. The sentence type category has been omitted as the data showed little variability over the two phases.

Figure 3.16 - Sentence Construction by Student



In Figure 3.16 the alternating high-low pattern of copied and authored sentences between the students' phase one and phase two cards is consistent for every student. This confirms the earlier observation that the second phase modifications encouraged more independent student authorship and that these modifications were successful with all students and not the result of an unusual data set. In similar manner, Figure 3.17 repeats the high-low pattern showing an increased use of graphic information by each student in the second phase work. The stability of the Notebook reference over both phases and by each student is also clearly shown in the following chart.

Figure 3.17 - Sentence Source by Student

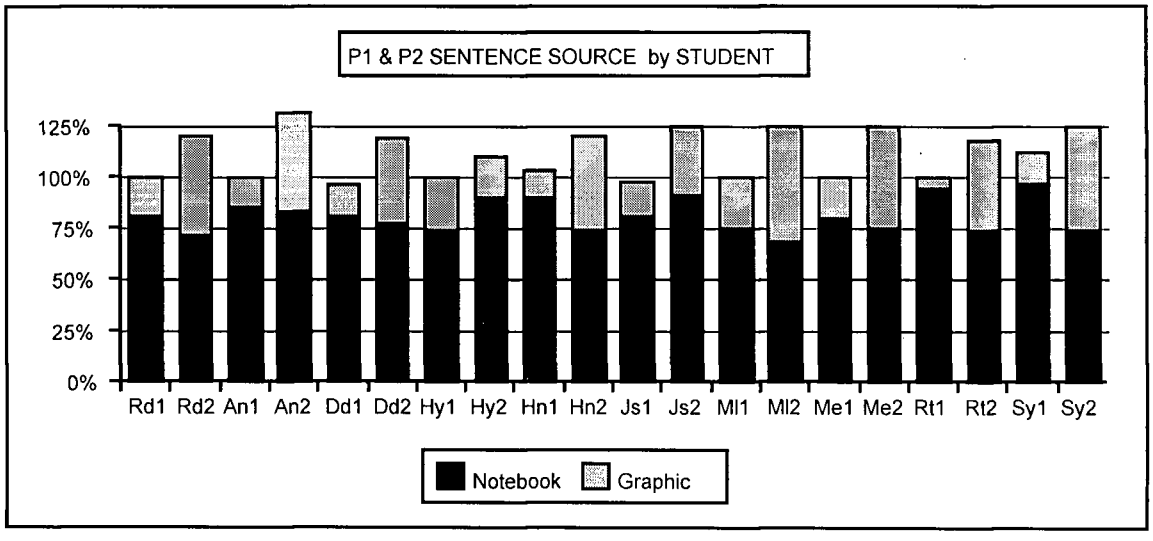
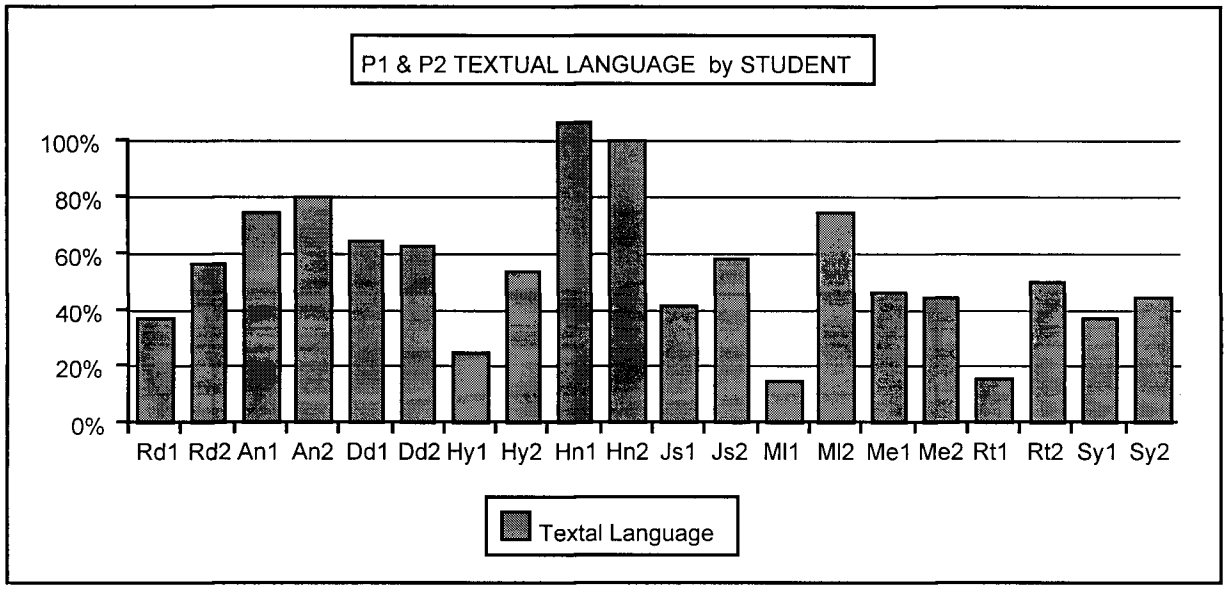


Figure 3.18 - Textual Language by Student



The textual language results shown in Figure 3.18 are not as perfectly regular as those for source and construction. For seven of the ten children their phase two sentences show a clear increase in the use of textual language features. For the remaining three students there is a slight decline in textual language instances. Table 3.22 gives the numbers for these results.

Table 3.22 - Change in Textual Language Use by Student

Student	P1	P2	Diff.	Student	P1	P2	Diff.
Richard (Rd)	38%	57%	19%	David (Dd)	64%	63%	1%
Allan (An)	75%	80%	5%	Helen (Hn)	108%	100%	8%
Harry (Hy)	25%	53%	28%	Millie (Me)	47%	44%	3%
James (Js)	42%	58%	16%				
Michael (Ml)	15%	75%	60%	.	.	.	.
Robert (Rt)	15%	50%	35%	.	.	.	.
Suzy (Sy)	38%	44%	7%	.	.	.	.
Means	35%	60%	24%	Means	73%	69%	4%

CHAPTER 4: CONCLUSION

Introduction

The research question asked: Can a Knowledge Framework based model of computer environments support English Second Language students in using Internet information to develop content knowledge and cognitive academic language skills?

The simple answer is "yes"; the more detailed answer is that variations in the supports offered to the students influenced the texture of the academic discourse produced. The following summary of the results outlines the ways in which the Knowledge Structure-based elements of the instructional environment were related to the content and language of the students' work.

Conclusions

Problem

The thesis addressed the following problem. Informal observations of student and teacher use of the Internet showed that students were able to access and navigate through vast amounts of information but had difficulty applying school research tasks within the Internet environment, students had difficulty attending to, identifying and selecting information relevant to teacher defined learning tasks. The expansive, hypertext nature of the World Wide Web and the attractive but often distractive nature of rich multimedia information sites were more supportive of browsing than of meaningful student learning. Thus, one aspect of the problem was how to design learning tasks to make student Internet access more meaningful and productive.

An additional aspect of the problem was how to provide students with a research and recording environment that would reduce the enticement to plagiarize material and would increase the opportunities for students to reflect on and work with the information they gathered. The goal was to design a task environment which could help consolidate students' content learning and encourage authentic writing.

Approach

The approach taken created a variety of scaffolds for student research, thinking and writing and embedded these in the students' digital task environment. These scaffolds were based on Mohan's work with Knowledge Structures (1986) and concepts of task design expressed in the Vancouver School Board's Framework for Teaching and Learning (1990). The research question then asked, can a Knowledge Framework based model of computer environments support English Second Language students in using Internet information to develop content knowledge and cognitive academic language skills?

Evidence

The central evidence was in the students' written and graphic products which were collected and analysed for textual and content features. Evidence of the processes students followed existed in the electronic record of their work which traced the process through each of the recording, working and writing phases. Further evidence was collected through observations of student interactions with partners, teachers and the computers during lesson time. Documentation of the students' interest and enjoyment of the study unit emerged in interviews and in their appropriation and extension of some visual and textual tasks.

Results

The results show that the ESL students were able to access, select and work collaboratively with appropriate information from the Internet to create authentic, student authored texts and visuals without plagiarism. They succeeded in learning and in expressing new content knowledge and they were supported in presenting their learning in original images and sentences incorporating features of academic writing.

The data show that students produced more 'original' sentences and fewer 'copied' sentences when the recording and reflecting tasks included language choices, point form notes and key visual graphics. Under these conditions students also made greater use of the graphics as a writing resource and included more 'textual' or academic word choices to explain their ideas.

In summary, conditions which most favoured original student work included knowledge structure-based recording and key visual tasks.

Limitations

Application of the results of the study are limited by the small number of students, the short duration and by the single site, group and curriculum topic.

Implications

Notwithstanding the limitations, the study offers insights which may be applied to further research questions and to teaching practice for both English first and second language learners. These questions are linked to concepts and issues identified in the review of the literature.

Implications for Research

The nature of the students' tasks examined in this project are related to Cummin's (1984) continua of communications and invite further research into the influence of cognitive and contextual supports set in a digital environment on student learning and writing.

The computer-based tasks designed for this project were a simple form of integrative, computer assisted language learning. The results suggest that digital learning environments which incorporate knowledge structure and key visual tools support student content understanding and language learning. Current research on human-computer interface design applied to multimedia educational environments connects features of task design with issues of student motivation, cognition and collaboration. There is an opportunity to conduct further research on student interactions in a more sophisticated, integrative CALL environment including key visuals and knowledge structure-based tasks.

Students were observed refining their content understanding and their language choices while engaged in a dialectical process between their developing key visuals, the Internet information resources and their partners and teachers. Students were paying attention to both the accuracy of their graphic representations and to their choice of words and expressions. Research could be undertaken to investigate the relationship between this process and the students' content knowledge and language choices. This research would relate to issues

regarding the roles of both the attention to form and the value of visual representations in ESL education.

Implications for Practice

For teachers, the research suggests that attending to issues of task design for identifying, recording and working with Internet information is related to student content and language development. This project thus invites further investigation of tasks which can help teachers make best use of Internet and computer resources to enhance student content knowledge. Additional research could also be undertaken into ways to support students in working with information textually and graphically to encourage thought and enable original writing. This research could also be extended to other curriculum areas and topics.

Discussion

The project developed one model for guiding student Internet research tasks.which could support language and content learning for English second language learners. For intermediate ESL students these sorts of constructive, project-based units offer the opportunity to participate in mainstream academic tasks using current technologies while concurrently developing academic language skills and knowledge. Within the rapidly changing digital world this research demonstrated teaching and learning strategies that enabled ESL learners to use the Internet and computer-based media collaboratively to communicate and represent their understanding in multiple ways.

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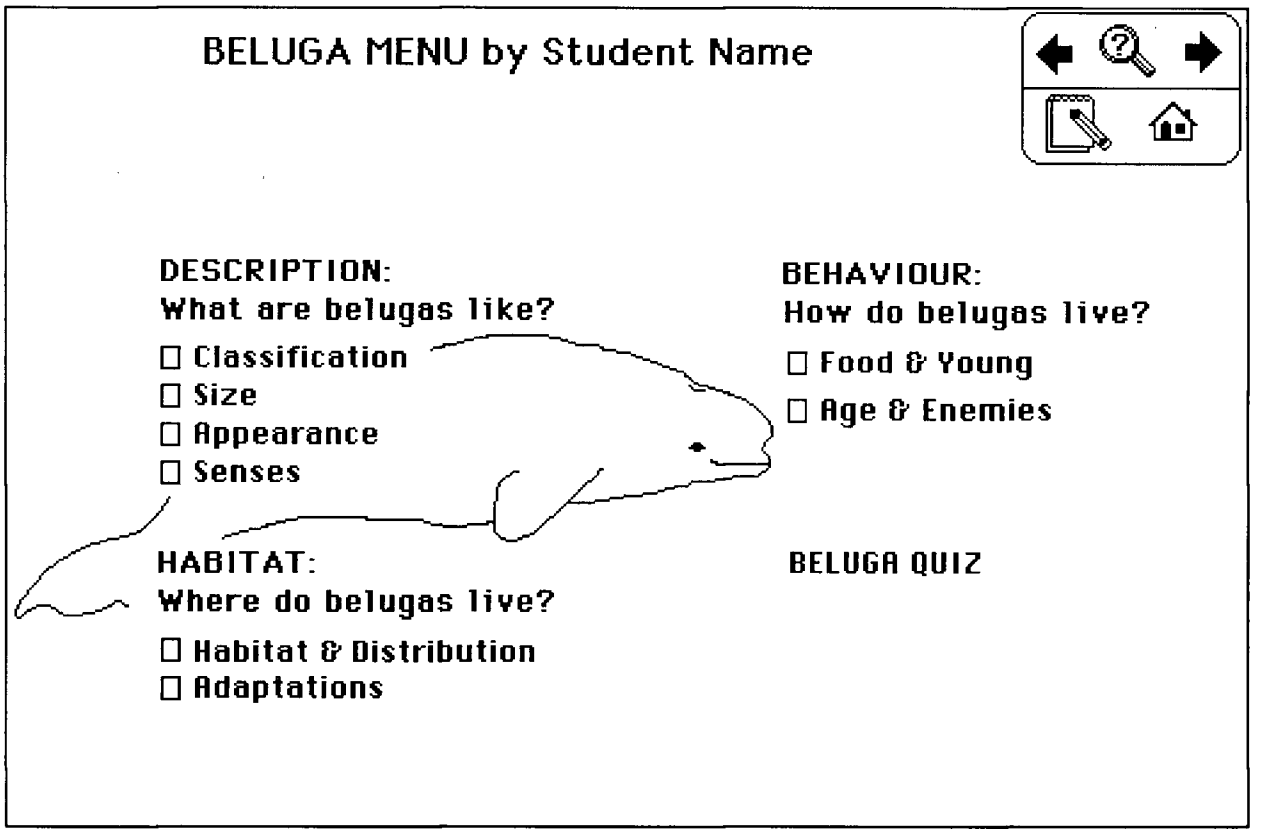
APPENDIX 1- Beluga HyperCard Stack

The images on the following pages show the template version of the HyperCard stack designed as an instructing, recording, writing and presenting space for the students. The cards are shown in sequence although the HyperCard software does not restrict students or viewers to a linear sequence. Each card was converted into Hypertext Markup Language and mounted on the school board's World Wide Web server. In this format additional links were added to the menu page to enable students to select information resource sites on the Web. This process of matching resource links directly to the students' tasks was used for the introductory phase of the project when the students were first becoming familiar with working on the Internet and working within the HyperCard and browser windows. The contents of the Notebook field are printed after each card illustration.

Figure A1.1 - Beluga Menu Card



Notebook:

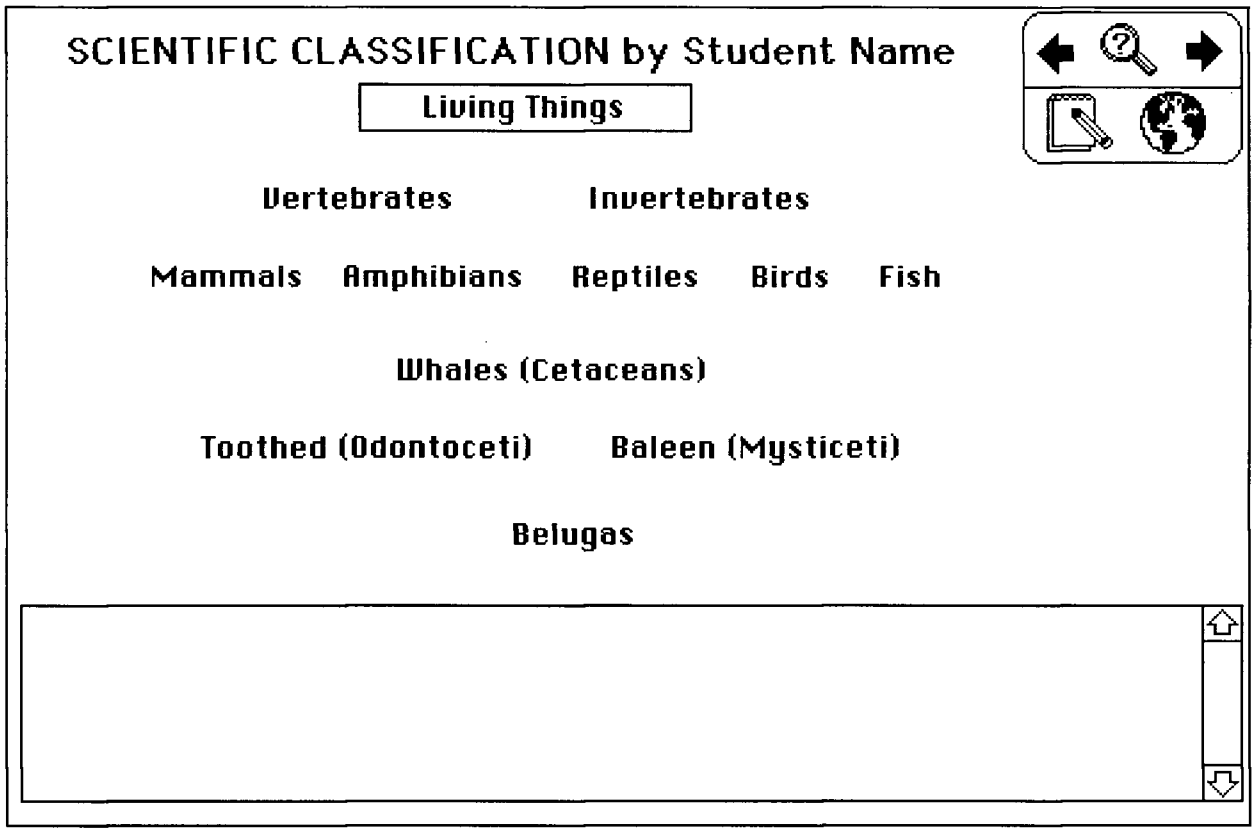
When you click the Notebook button you can hide or show the Notebook.

The Notebook contains instructions for what to do on each screen. It also contains keywords and notetaking help.

Record Internet information in the Notebook by typing or by using Edit > Copy & Paste.

Your good sentences will be typed in a different field.

Figure A1.2 - Beluga Classification Card



Science names are organized by group from large to small.

Each scientific name tells you something about beluga whales.

Cetacea - the biggest group is Cetacea. All whales belong to ...

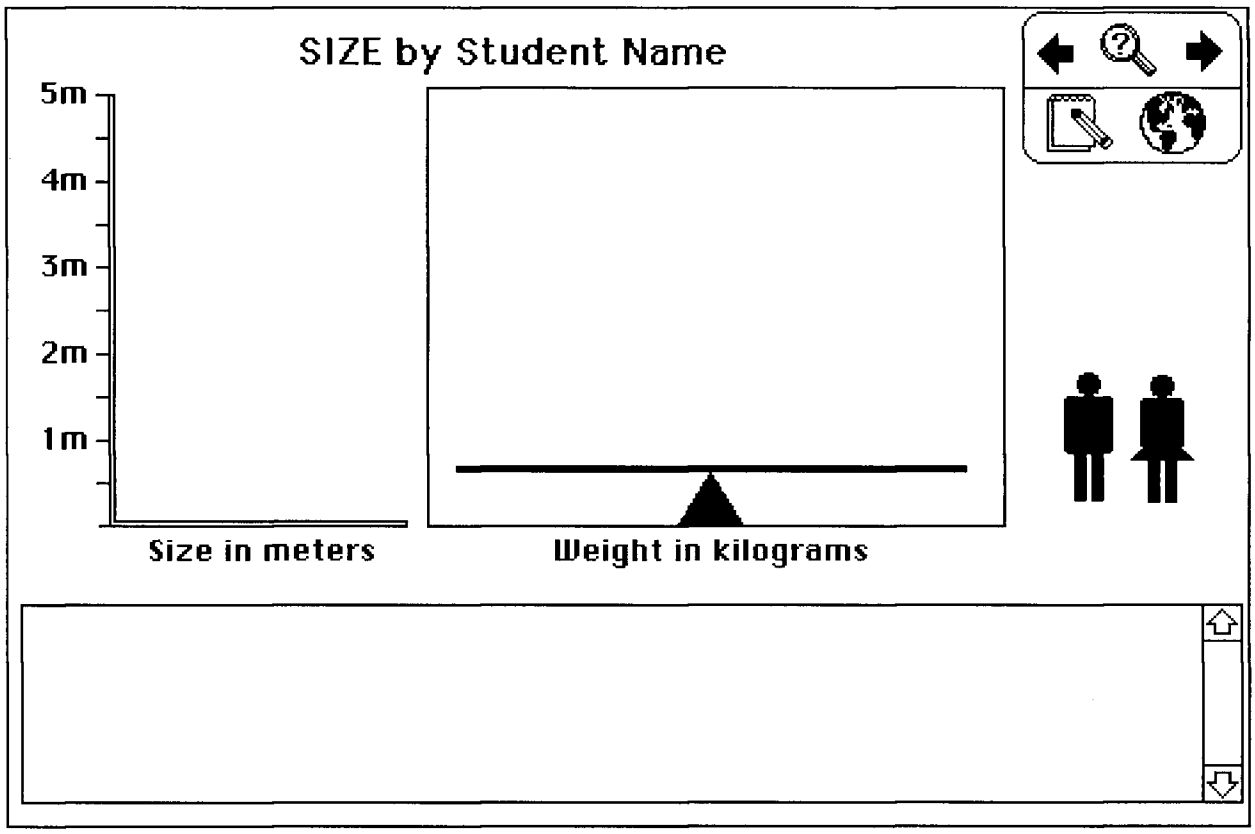
Odontoceti - tells you that belugas are ...

Delphinapterus - means that belugas are "..."

Leucas - tells you that belugas are "..."

Use the drawing tools to draw a frame around the words which describe belugas. Connect the words and frames which describe belugas with lines.

Figure A1.3 - Beluga Size Card



Choose either male or female averages to compare.

Average male/female beluga length =

Average female/male beluga weight =

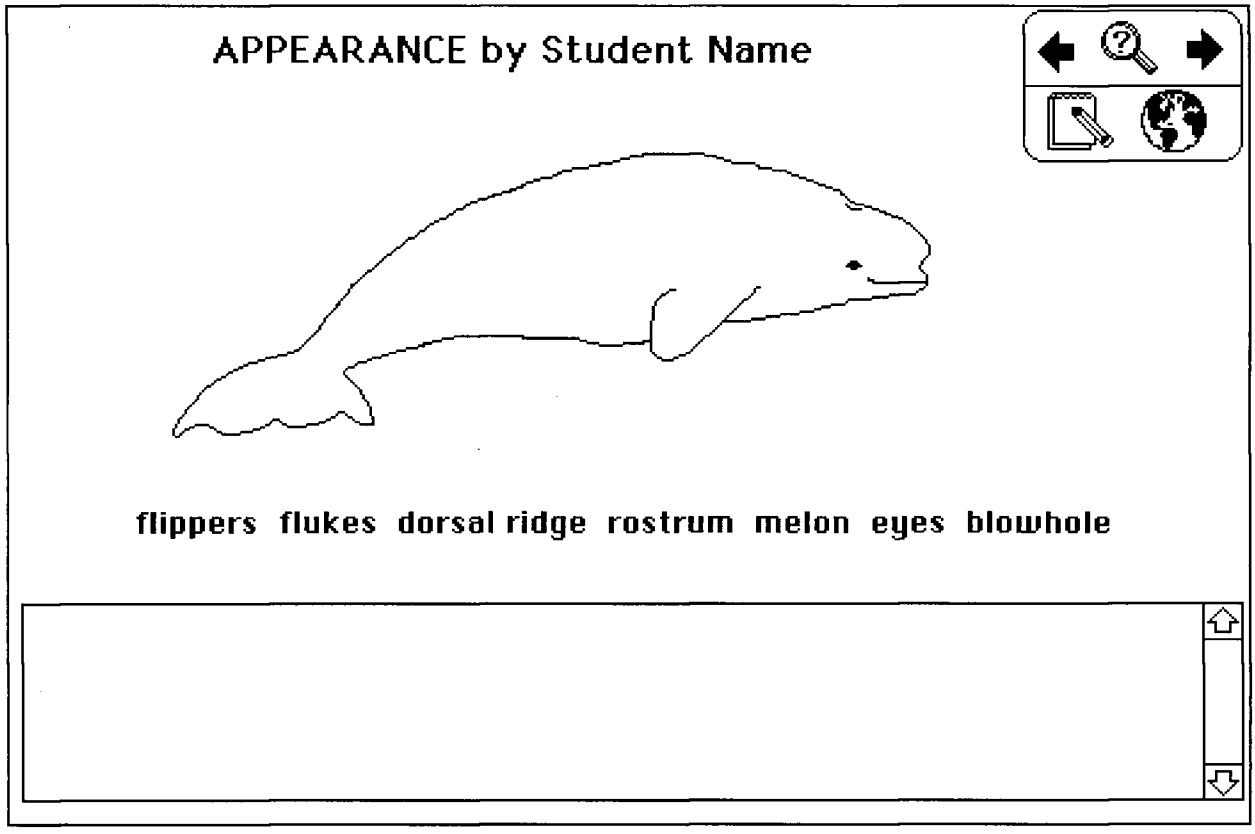
Average male human height = 1.7 m; weight = 73 kg

Average female human height = 1.6 m; weight = 61 kg

An average beluga is ? times longer than a human and ? times heavier.

Draw a beluga and a human on the Size Chart to show the difference. Draw a beluga on one side of the Scale and calculate how many humans would need to go on the other side to balance it.

Figure A1.4 - Beluga Appearance Card



COLOUR - Belugas are ... when they are adults and ... when they are born. As they grow they become more ...

PECTORAL FLIPPERS - Belugas use their flippers to ...

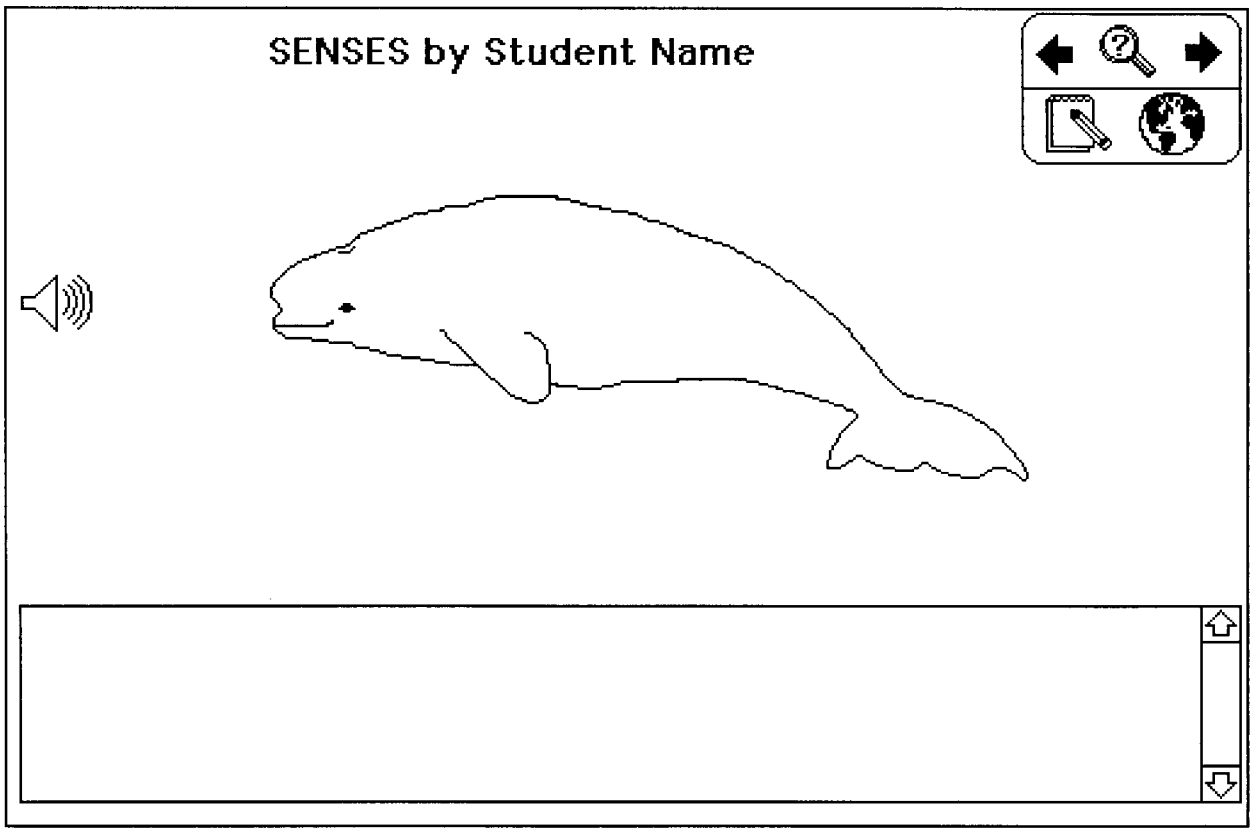
ROSTRUM - The rostrum is like a ...

MELON - The melon is probably used for ...

BLOWHOLE - A beluga whale ... through its blowhole.

Key parts to label on your diagram are: flippers, flukes, dorsal ridge, rostrum, melon, eyes, blowhole.

Figure A1.5 - Beluga Senses Card



Whales live in the ocean and thus some of their senses work differently than ours. An acute sense is one that is very good.

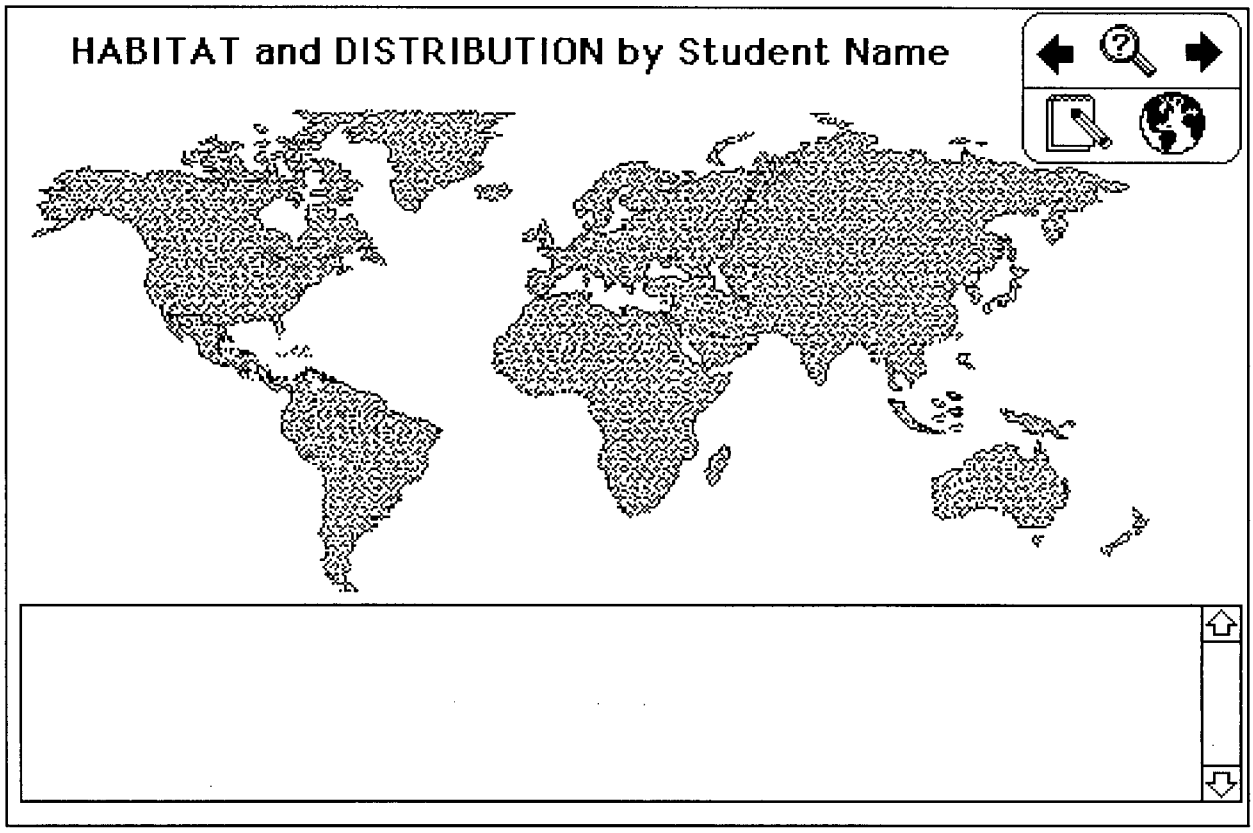
Hearing - Humans hear through their ... but belugas hear through their ...

Belugas have an acute sense of ... and ...

Belugas have no sense of ...

On the diagram, draw an arrow from the sound waves to show where belugas receive most sounds.

Figure A1.6 - Beluga Habitat & Distribution Card



Habitat tells you about the environment that belugas prefer. Distribution tells you where they live around the world. Migration tells you where they travel to during the seasons. Population tells you how many belugas are living around the world.

DISTRIBUTION - Belugas live in the ... Ocean.

DISTRIBUTION - Sometimes they are found in ...

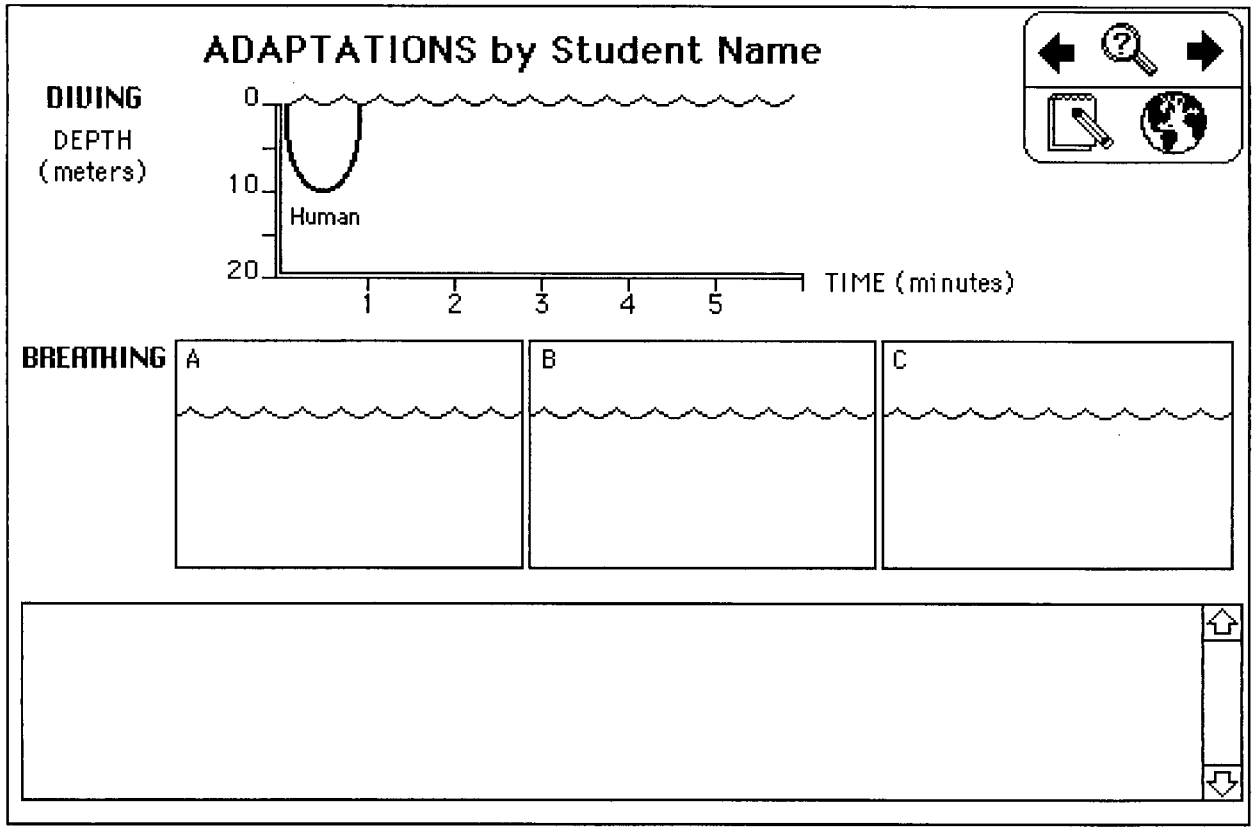
HABITAT - Belugas live in ... waters as cold as ... C.

MIGRATION - Most belugas migate ... in ..

POPULATION - There are about ... belugas in the world.

On the map, mark the areas where belugas live; draw arrows to show their migration paths.

Figure A1.7 - Beluga Adaptations Card



Adaptations for an Aquatic Environment

Aquatic means water or ocean. Mammals that live in water have to be able to:

- move (swimming and diving);
- breathe (respiration), and;
- control their body temperature (thermoregulation).

Diving:

Belugas usually dive about ... meters deep.
I think people can dive about ... meters deep.
A beluga dive usually lasts for about ... minutes.
I think most people could stay under water for about ... minute(s).

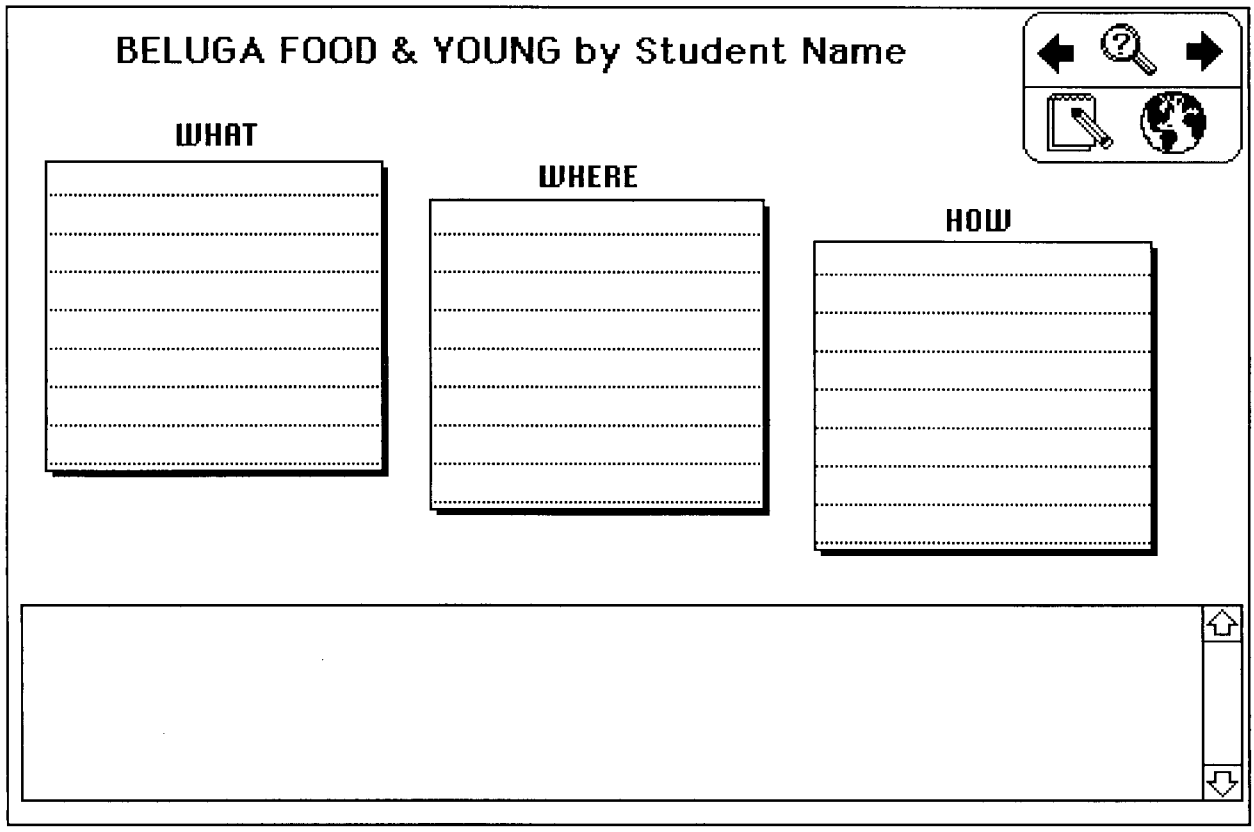
Respiration (Breathing):

A beluga breathes through its ...
Draw and label the three steps showing how a beluga takes a breath.

Thermoregulation (Body Heat):

Body fat or ... helps ...

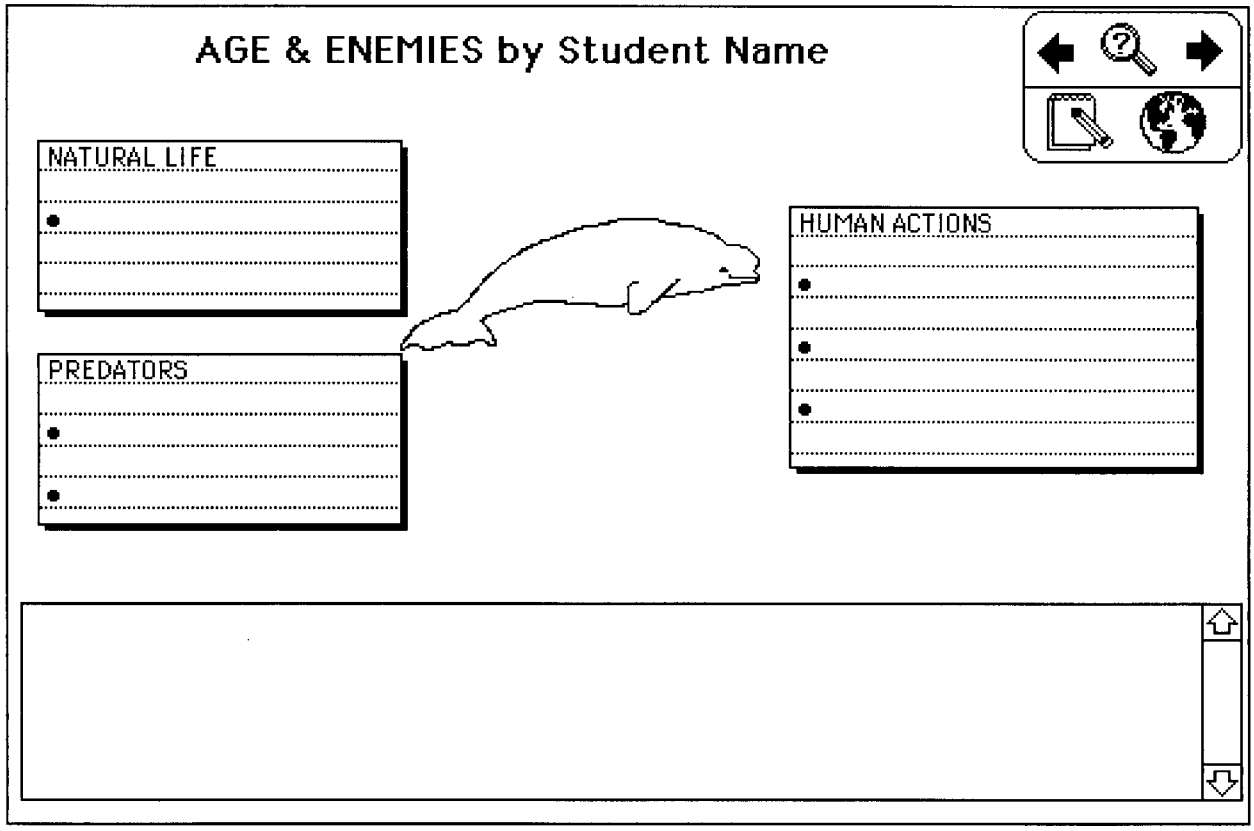
Figure A1.8 - Beluga Food & Young Card



Fill in the three boxes to list

- what belugas eat, and, what they feed their young;
- where they find food in the ocean;
- how they get and eat their food.

Figure A1.9 - Beluga Age & Enemies Card



Age (longevity):

In the wild, belugas can live ... years.

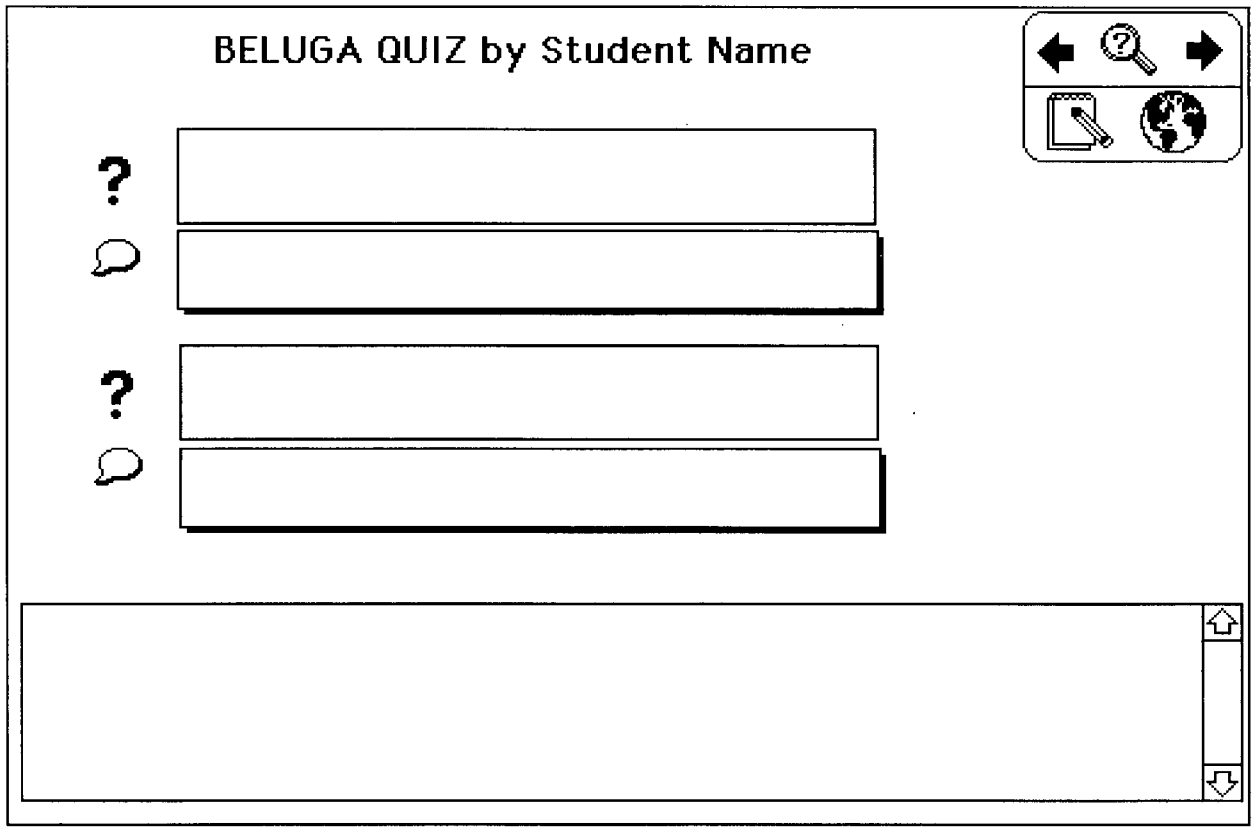
Predators (enemies):

List two other animals which attack belugas.

Human Actions:

List three things humans have done to threaten belugas.

Figure A1.10 - Beluga Quiz Card



Beluga Quiz:

Copy and paste two of your pictures on this screen.

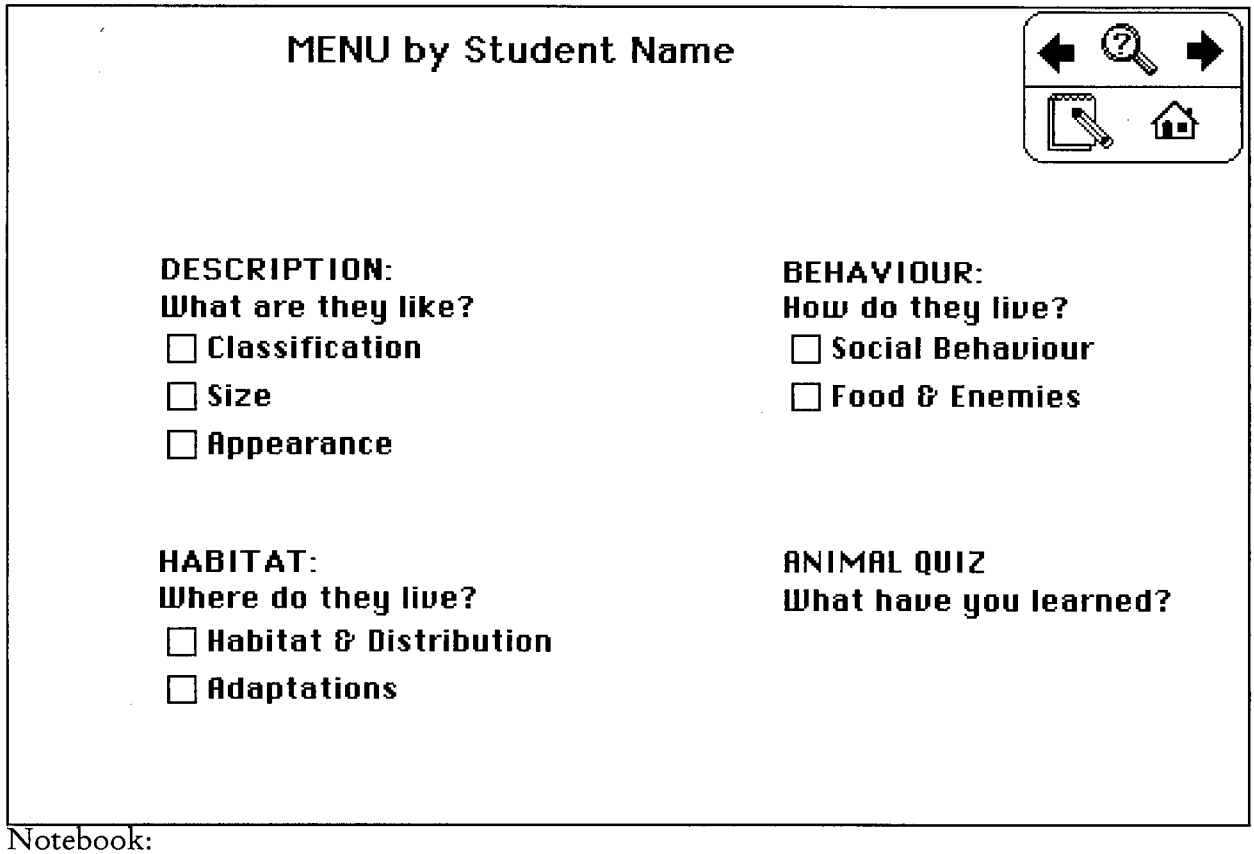
Draw a line from each Question Mark button to a picture.

Type the Questions in the question box, and, the Answers in the answer box.

APPENDIX 2- Marine Mammals HyperCard Stack

The images on the following pages show the template version of the Marine Mammals HyperCard stack designed as an instructional, record keeping and presentation space for the students. The cards are shown in sequence although the HyperCard software does not restrict students or viewers to following a strict sequence. The graphics and Notebook instructions for each card were converted into Hypertext Markup Language and mounted on the school board's World Wide Web server to be available to other teachers as a template file. Links to Internet information resources were compiled into a master index page which offered students numerous choices in selecting sites to explore. The contents of the Notebook field are printed after each card illustration.

Figure A2.1 - Marine Mammals Menu Card



Notebook:

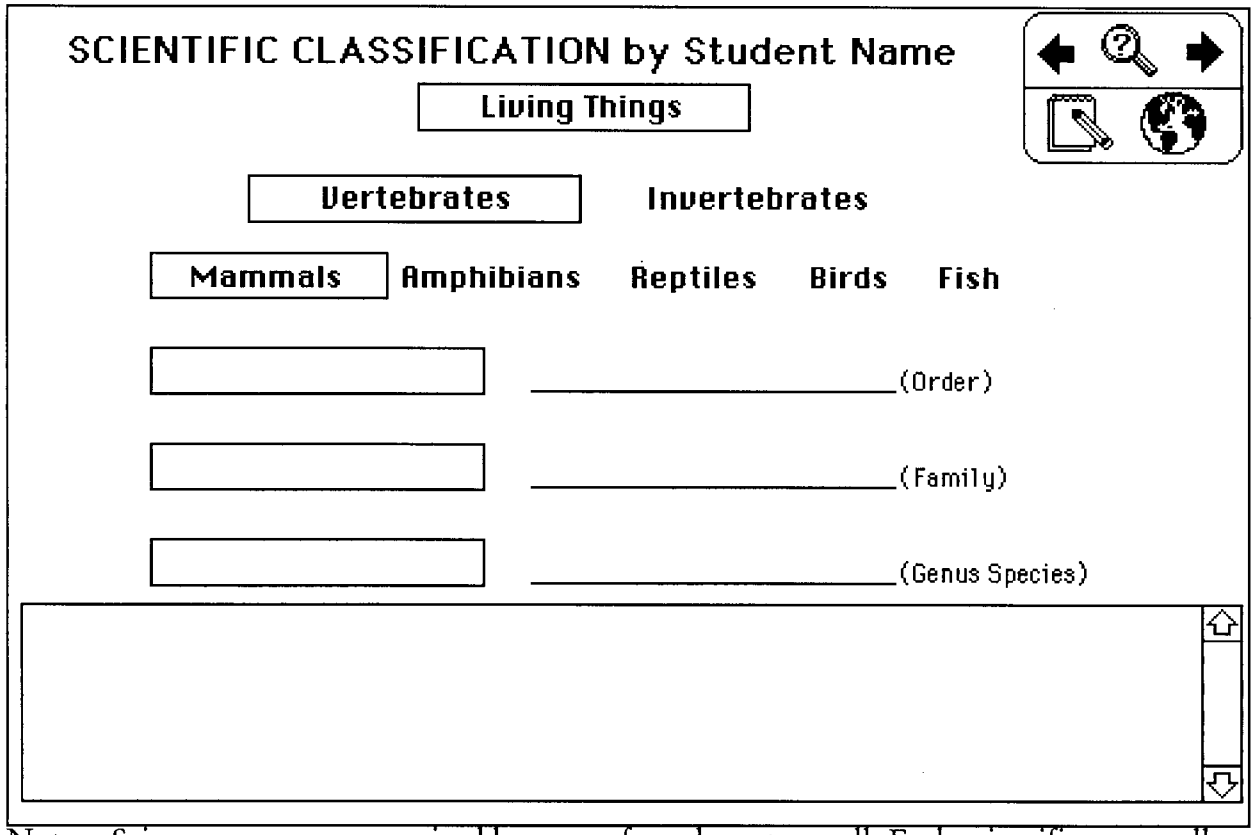
Click the Notebook Button to hide or to show the Notebook.

The Notebook contains instructions for what to do on each screen. It also contains keywords and notetaking help.

Record Internet information in the Notebook by typing or by using Edit > Copy & Paste.

Use the picture or graphic on each screen and your Notebook notes to help write your good sentences.

Figure A2.2 - Marine Mammals Classification Card



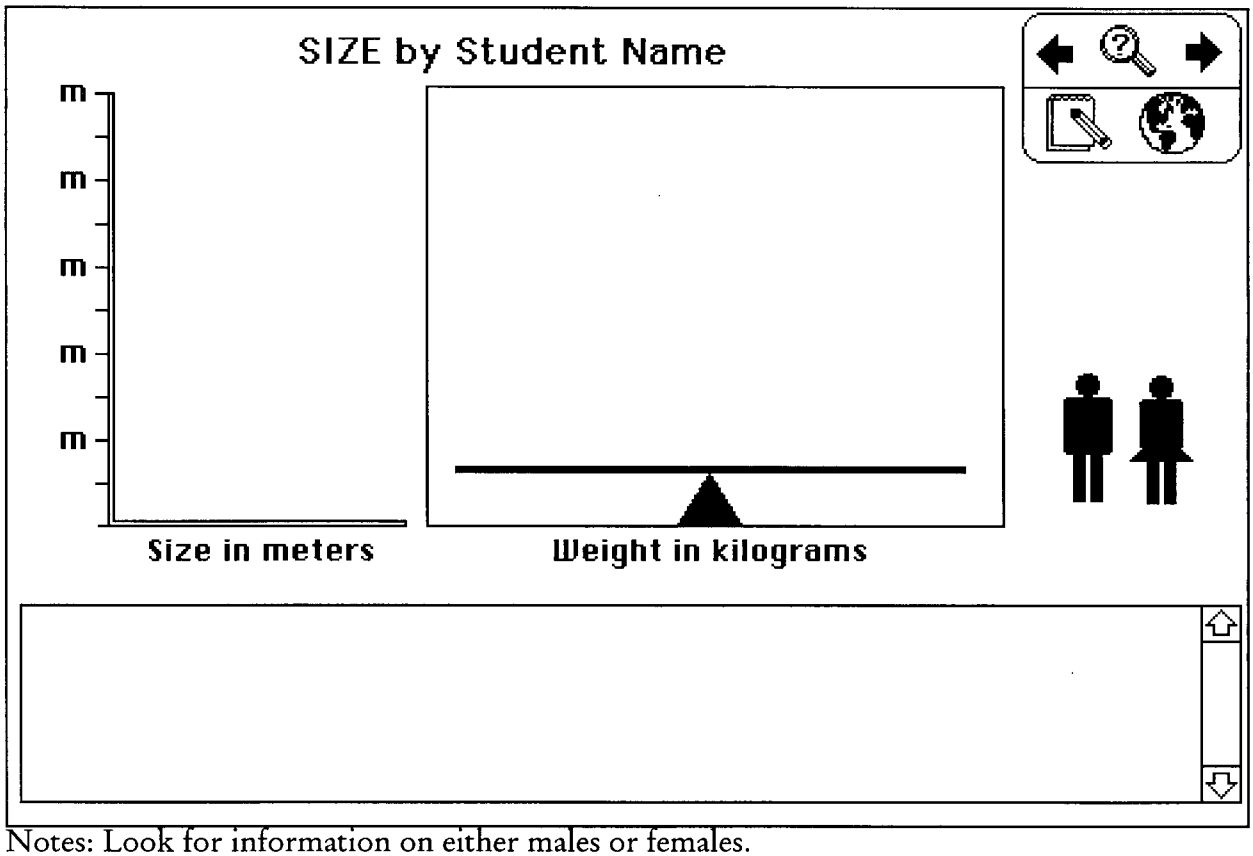
Notes: Science names are organized by group from large to small. Each scientific name tells you something about the animal and how it is grouped or classified. Find these science names and meanings to describe your animal.

- Order =
- Family =
- Genus Species =

Words for Classification: Use some of these words in your good sentences.
is a kind of; belongs to; is grouped with; is a member of; means; tells you that;

Drawing Instructions: Use the drawing tools to complete the chart. Put the scientific name in the box and write its meaning on the line. Draw frames and lines to show the scientific classification of the animal.

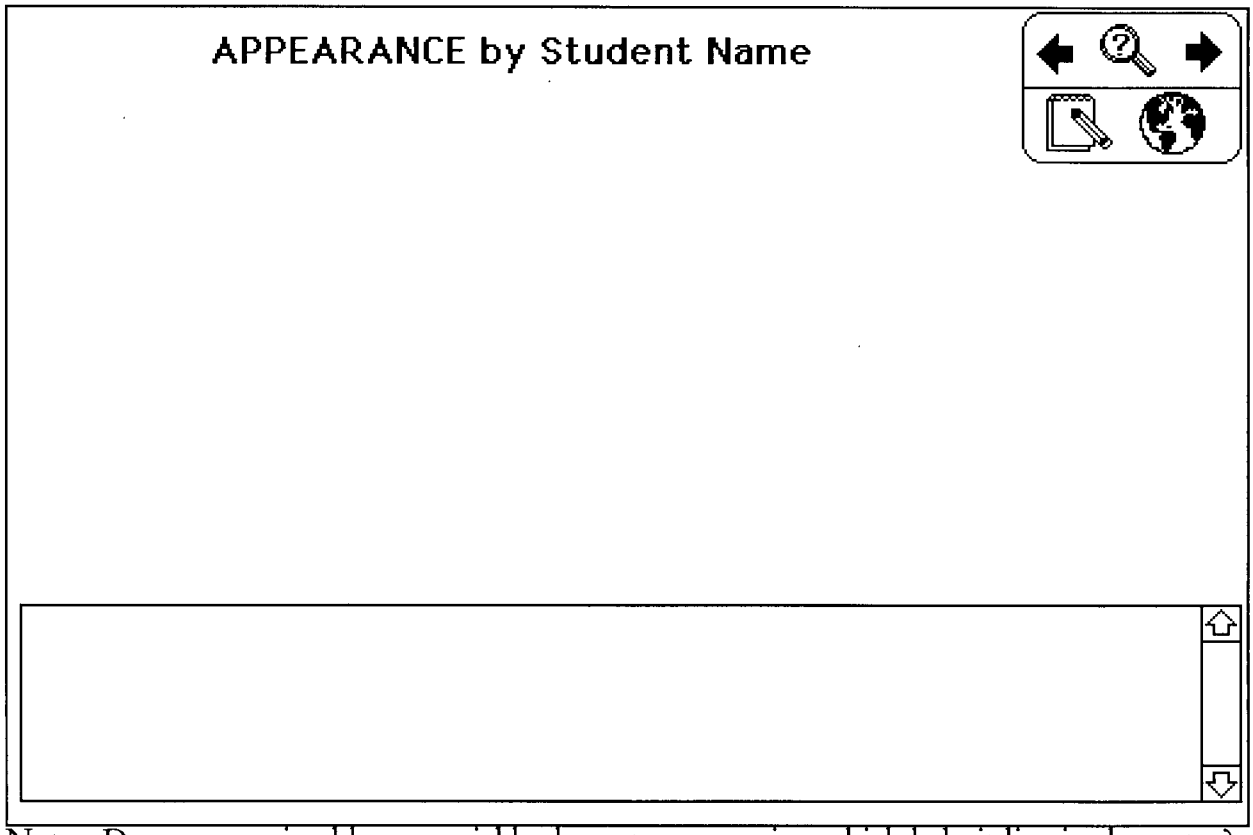
Figure A2.3 - Marine Mammals Size Card



Notes: Look for information on either males or females.
Animal:
- Average male/female length or height =
- Average female/male weight =

Human:
Average male human height = 1.7 m; weight = 73 kg
Average female human height = 1.6 m; weight = 61 kg
Words for Description: Use some of these words in your good sentences.
longer; shorter; smaller; larger; heavier; lighter; is ... times larger than ...; is ... times taller than ...; is ... times heavier than ...
Drawing Instructions: Draw your animal and a human on the Size Chart to show the difference. Draw your animal on one side of the Weight Scale then calculate and draw the number of humans needed to balance the scale.

Figure A2.4 - Marine Mammals Appearance Card



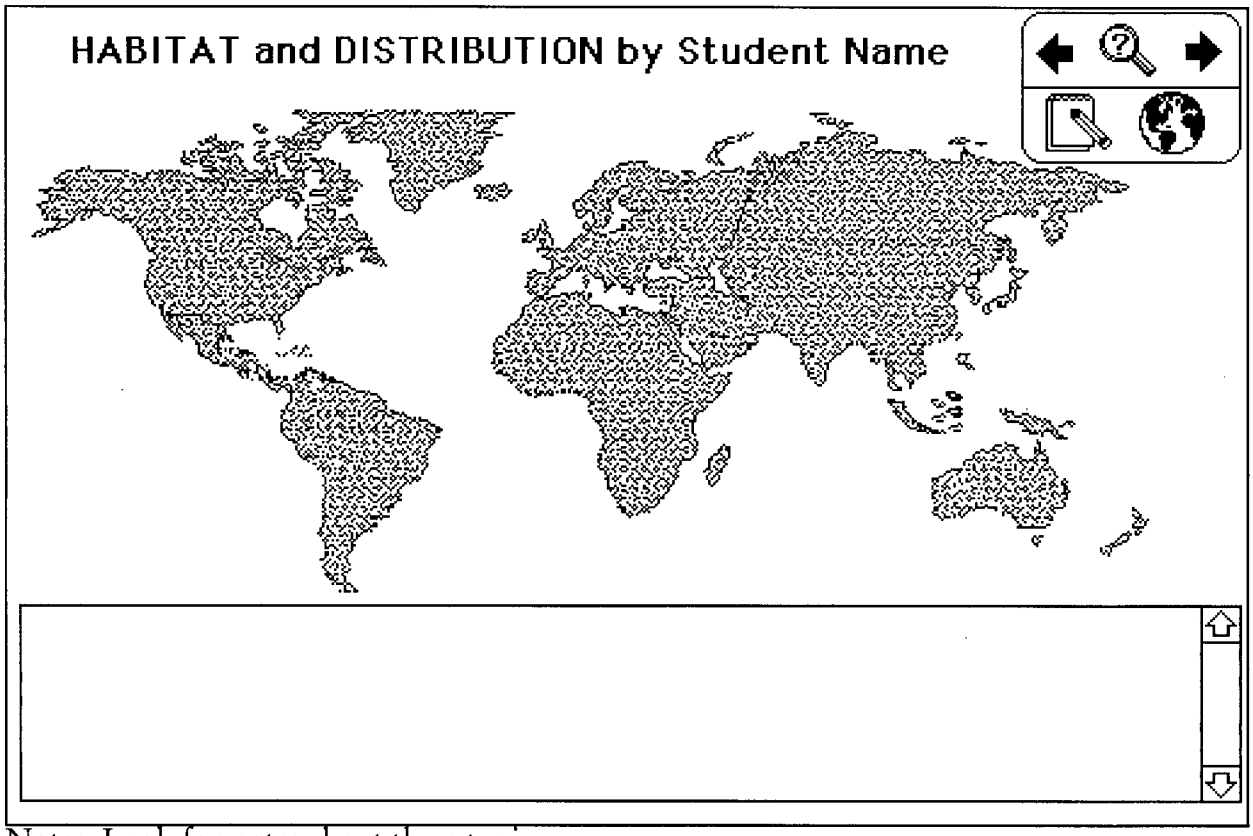
Notes: Does your animal have special body parts or covering which help it live in the water? Put notes about your animal's appearance here:

- colour =
- body covering =
- shape =
- special parts =
- other notes =

Words for Description: Use some of these words in your good sentences
used for; on top; on the bottom; at the front; at the back; along the sides; smooth; rough; covered with; shaped like; light, dark (colour)

Drawing Instructions: Draw, or copy and paste a good image of your animal onto this card. Label the key body parts and be sure to include any body parts which make this animal special.

Figure A2.5 - Marine Mammals Habitat & Distribution Card



Notes: Look for notes about these topics.
Habitat tells you about the environment your animal prefers.

- kinds of water bodies (deep or shallow water, warm or cold) =

Distribution tells you where it lives around the world.

- Oceans =
- Other locations (seas, bays, gulfs, straits, etc.) =

Migration tells you where it travels during the seasons. Find out if your animal migrates or stays in one place during the seasons.

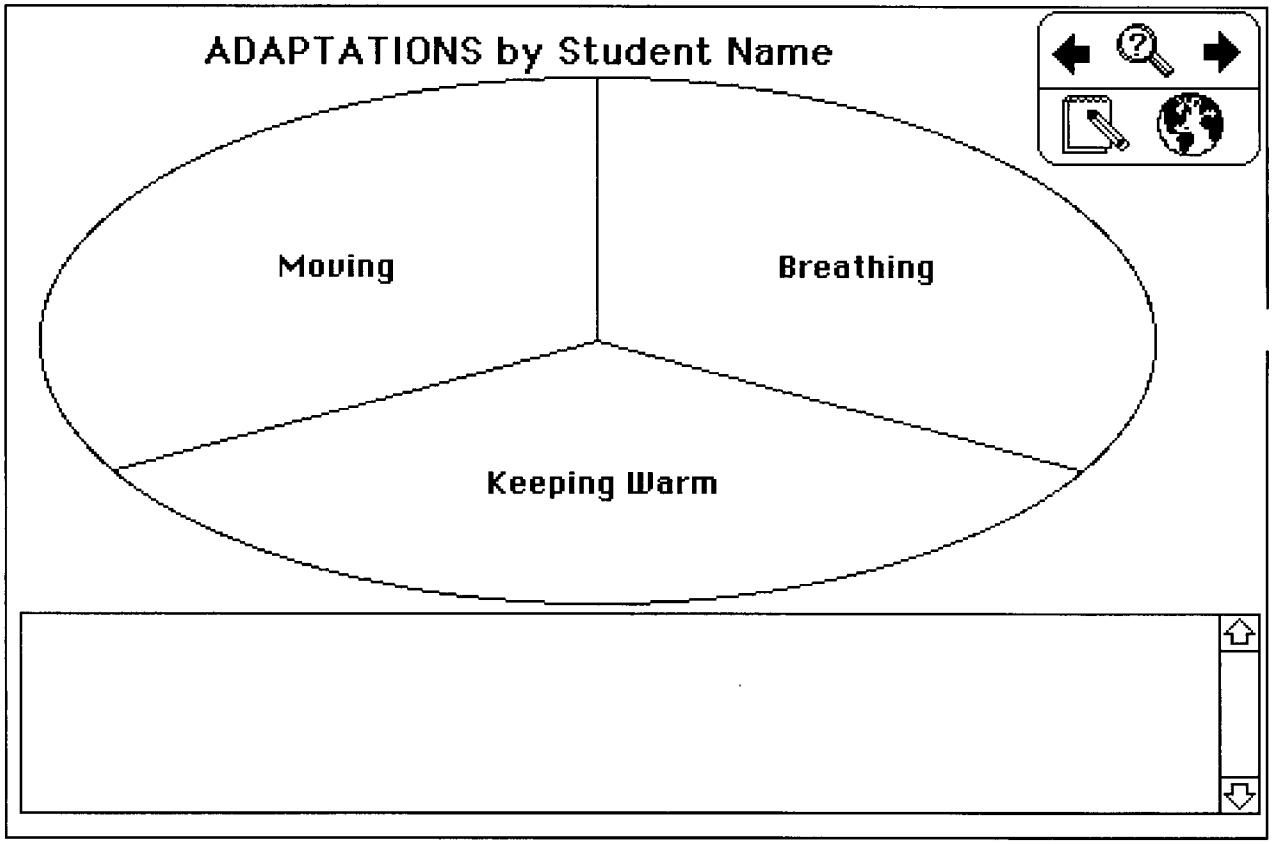
- Migrates = yes / no
- If yes, summer =

winter =
Population tells you how many animals are living around the world.

- Population =

Words for Description: Use some of these words in your good sentences
is found in; likes to live in; prefers; is often; usually; always; during the winter/summer/spring/fall;
Drawing Instructions: On the map, mark and label the areas where the animal lives. If the animal migrates, draw arrows to show migration routes.

Figure A2.6 - Marine Mammals Adaptations Card



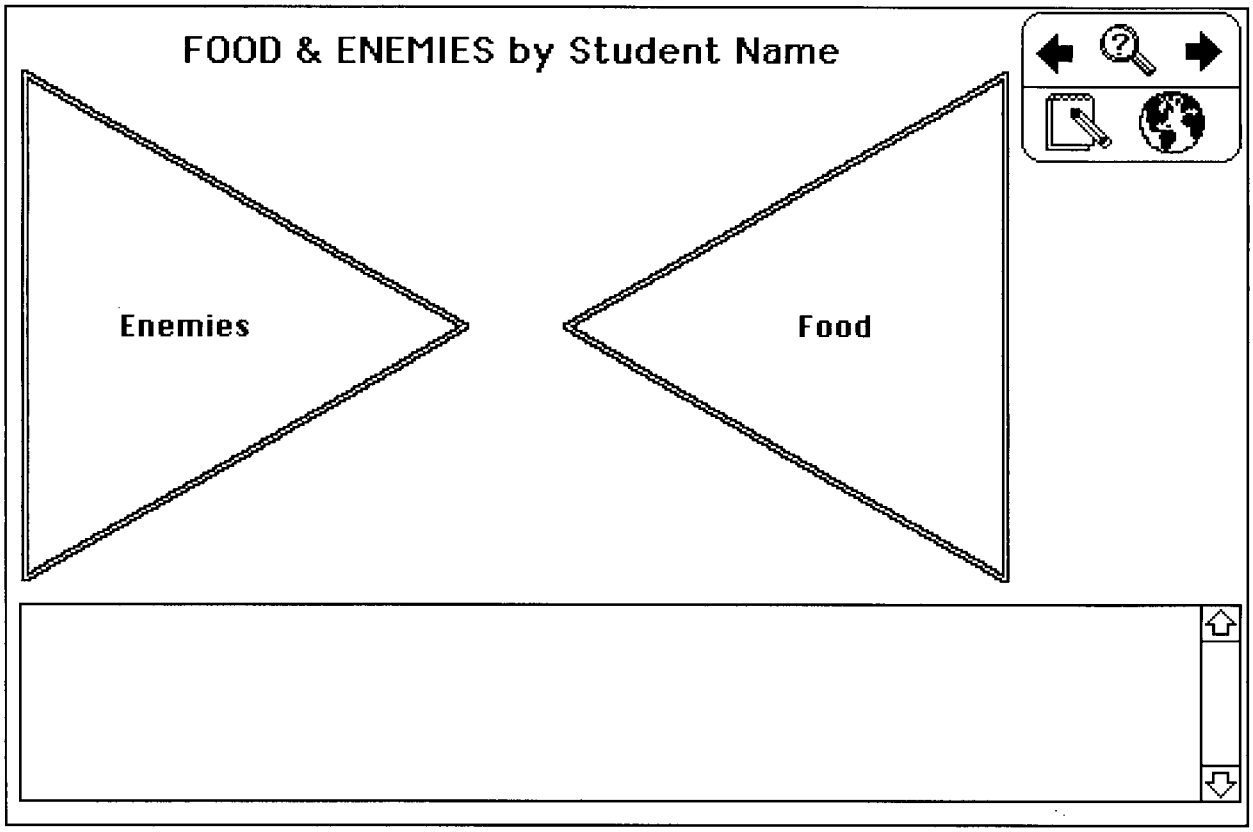
Notes: Marine mammals have bodies that are adapted to the water, they must be able to move (swimming and diving); breathe (respiration), and; keep warm (thermoregulation = control body temperature). Look for notes on:

- Moving =
- Respiration (Breathing) =
- Thermoregulation (Body Heat) =

Words for Description: Use some of these words in your good sentences.
is able to; breathes through; can hold its breath for; stays warms because of;

Drawing Instructions: Put keywords from your notes onto the diagram to show how this marine mammal is adapted or able to move, breathe and keep warm in the water.

Figure A2.7 - Marine Mammals Food & Enemies Card

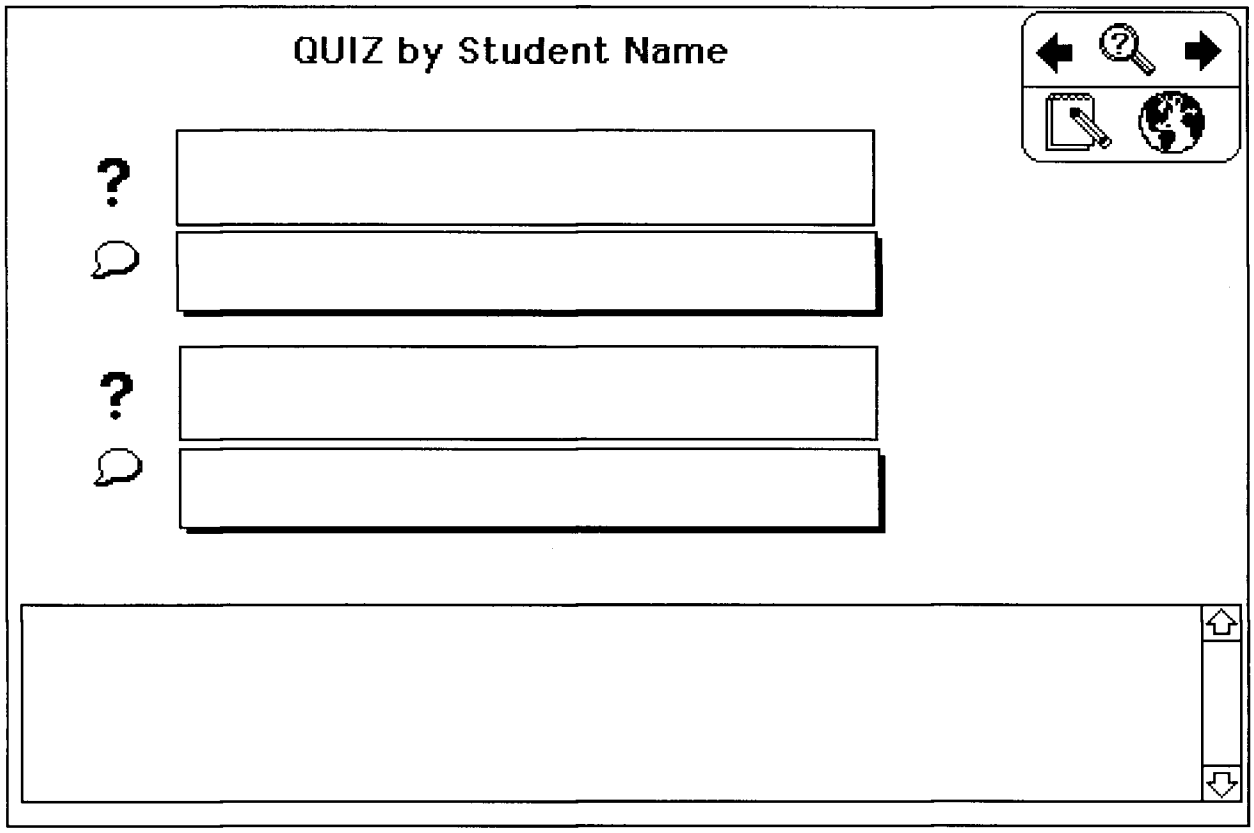


Notes: Look for information to tell you:
- what it likes to eat =
- how and where it gets its food =
- who its enemies are =
- how humans are helping or hurting this animal =

Words for Description: Use some of these words in your good sentences.
is able to; likes to; usually; always; often; because; as a result of;

Drawing Instructions: Fill in the the triangles to list keywords that show
- what enemies or dangers this marine mammal has;
- what its food is.

Figure A2.8 - Marine Mammals Quiz Card



Quiz:

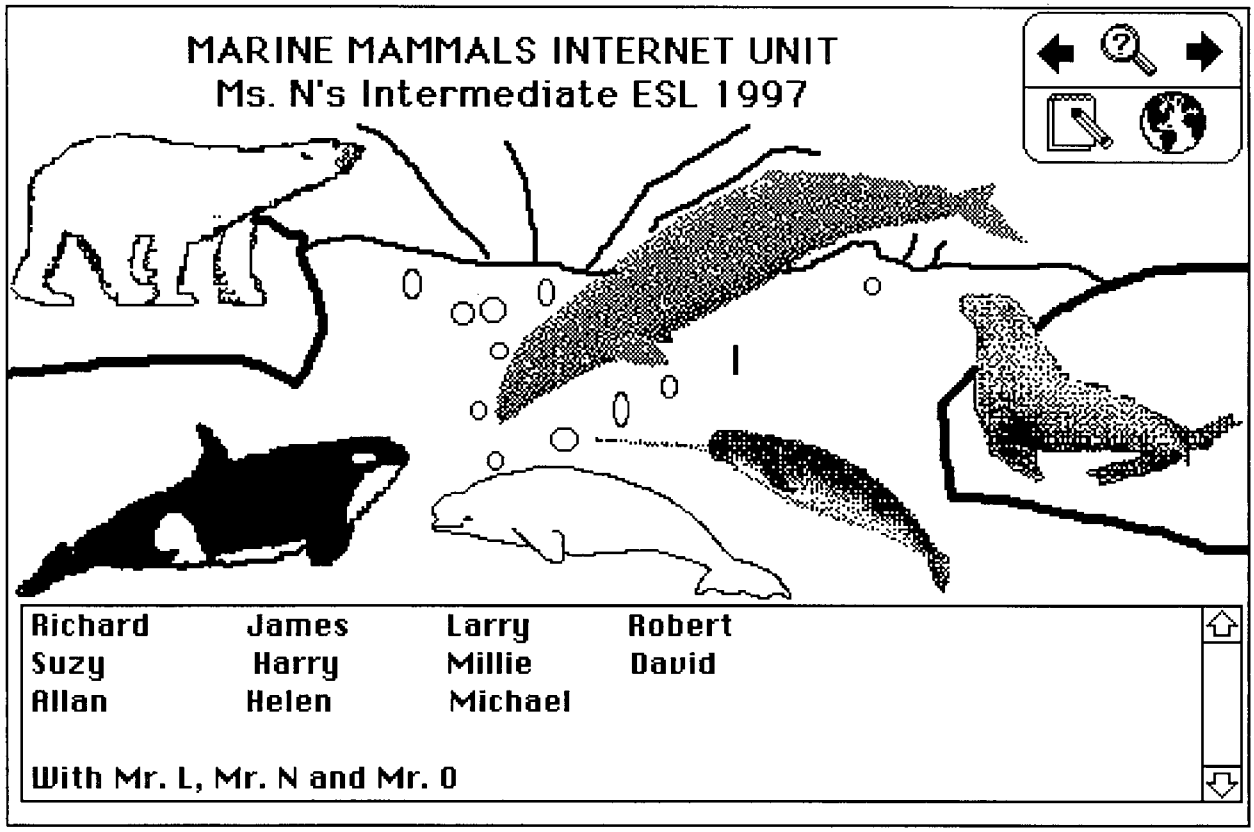
Copy and paste two of your pictures on this screen.

Draw a line from each Question Mark button to a picture.

Type the Questions in the question box, and, the Answers in the answer box.

Words for Questions & Answers:
What can/is;
When does/is;
Where does/is;
How does/is;
Why does/is;

Figure A2.9 - Marine Mammals Internet Unit Title Card



The menu presented above is final project menu which was created as the unit menu for the compiled HyperCard stack containing the work of all the students. This collated stack resides on the school's local area network as a reference for future classes and as a further chapter in the ever growing electronic projects collection of the classroom teacher and teacher/librarian.

APPENDIX 3 Marine Mammals Internet Homepage

Figure A3.1 - Marine Mammal Resources Page

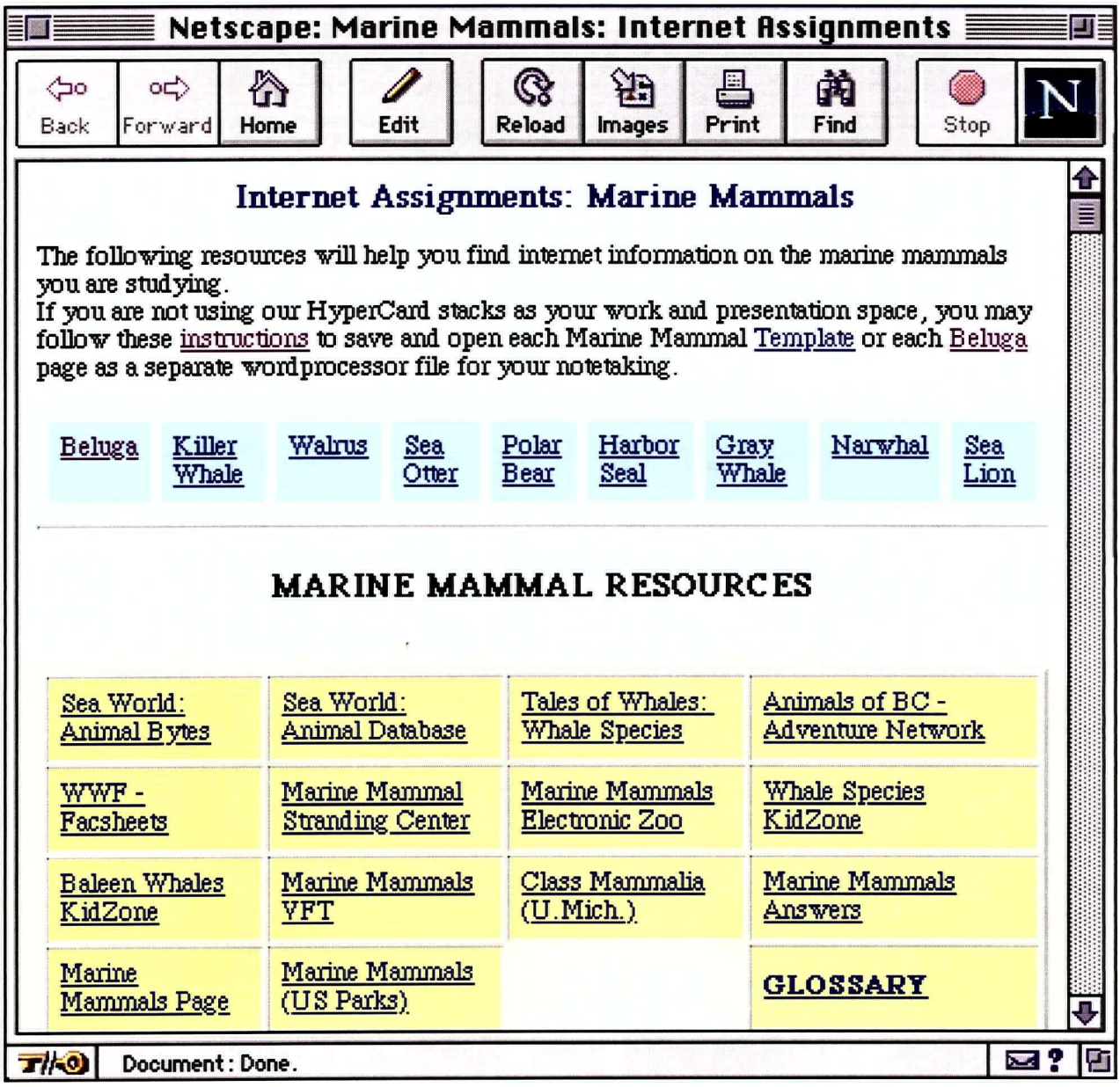


Figure A3.2 - Beluga & Killer Whale Page

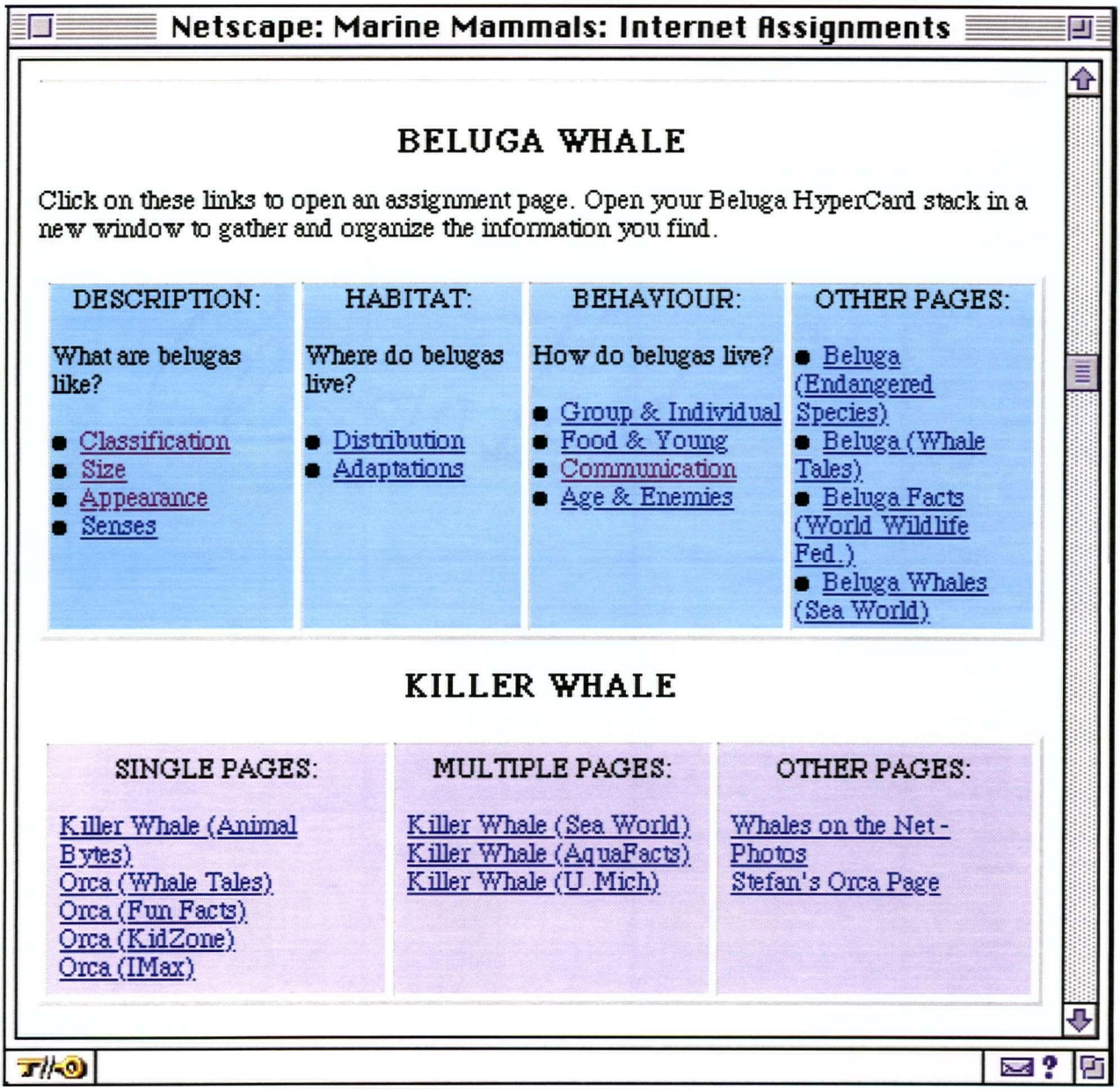


Figure A3.3 - Walrus, Sea Otter & Polar Bear Page

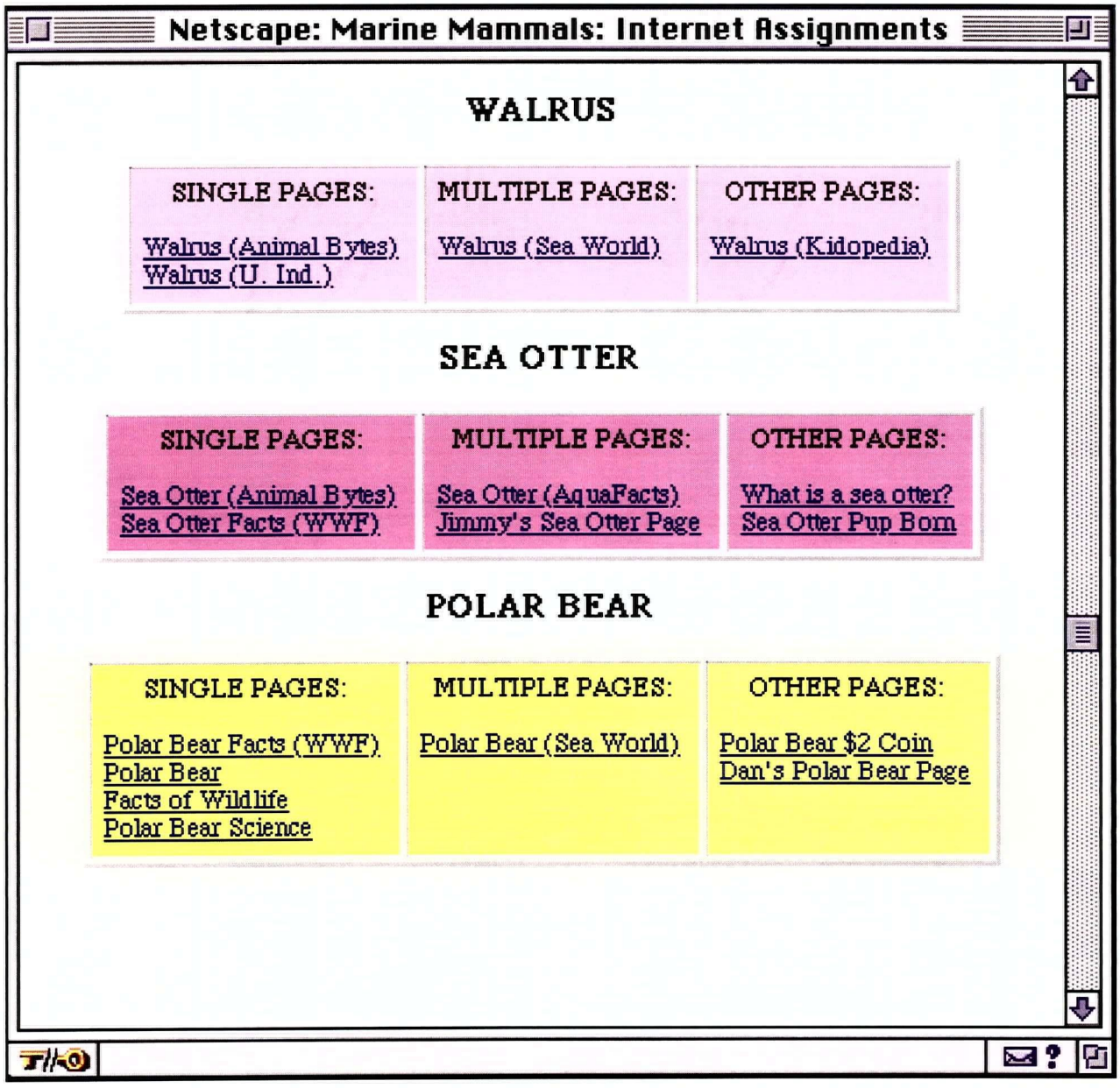


Figure A3.4 - Harbor Seal, Gray Whale, Narwhal & Sea Lion Page

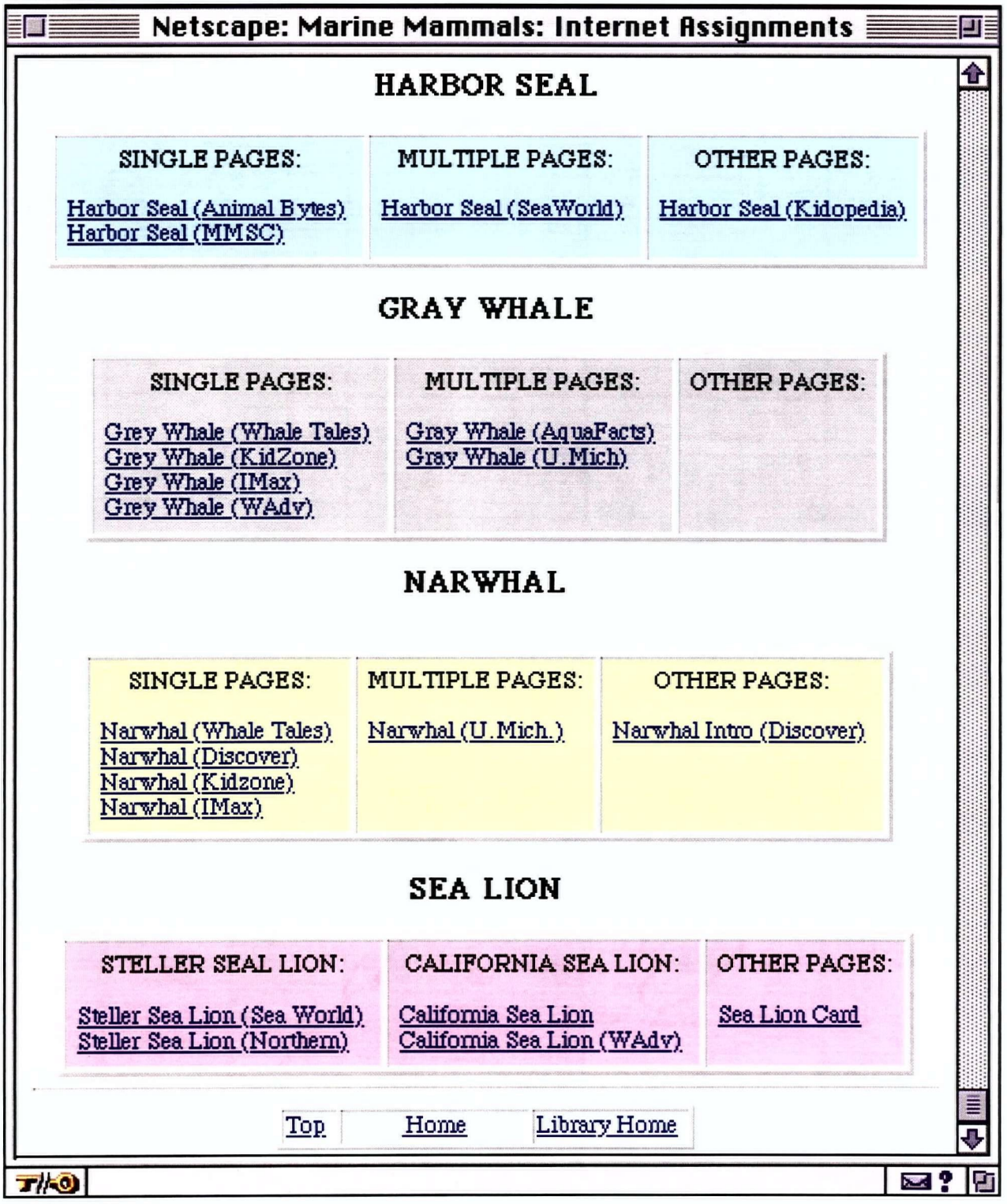


Figure A3.5 - Beluga Description Page

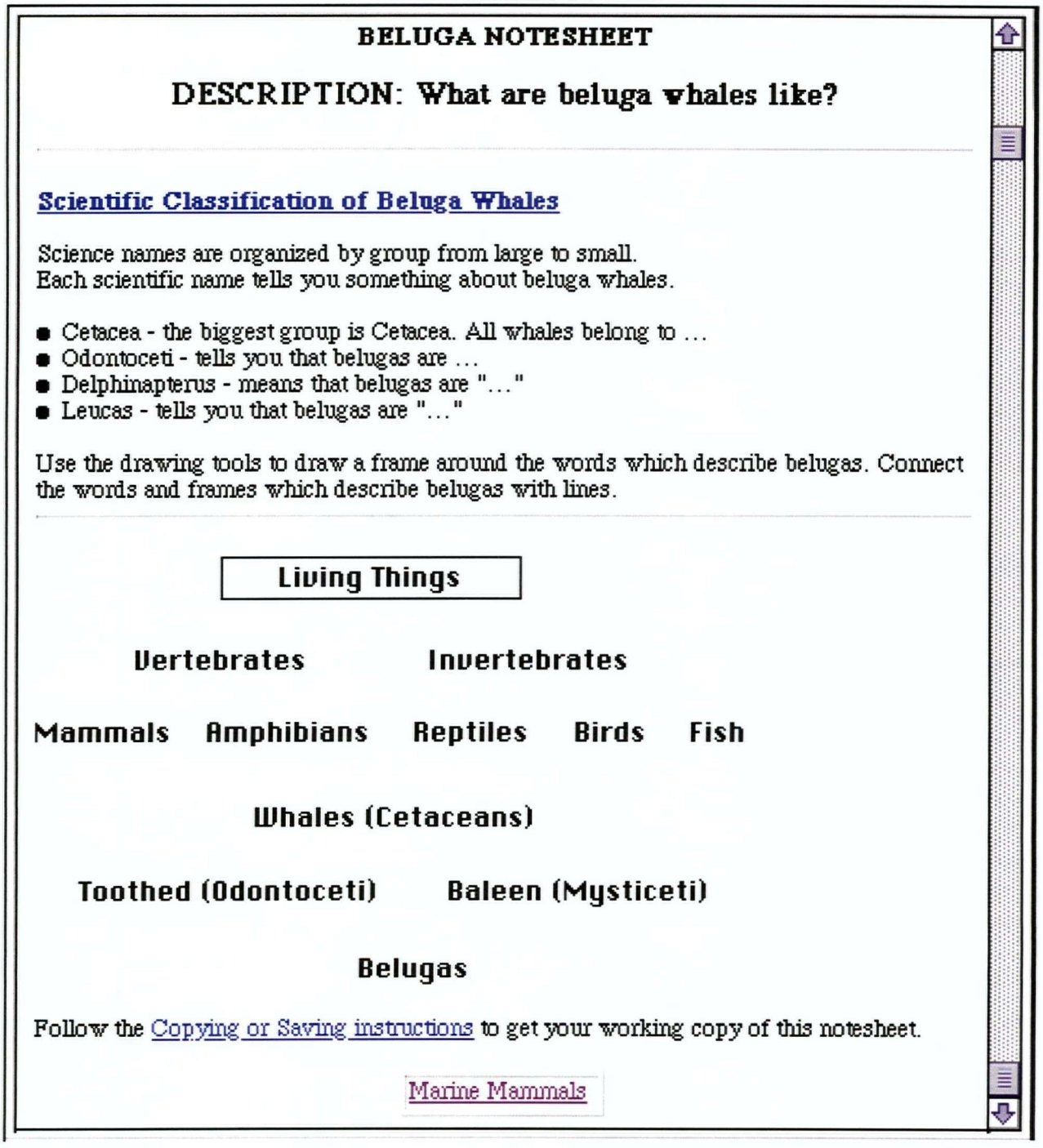
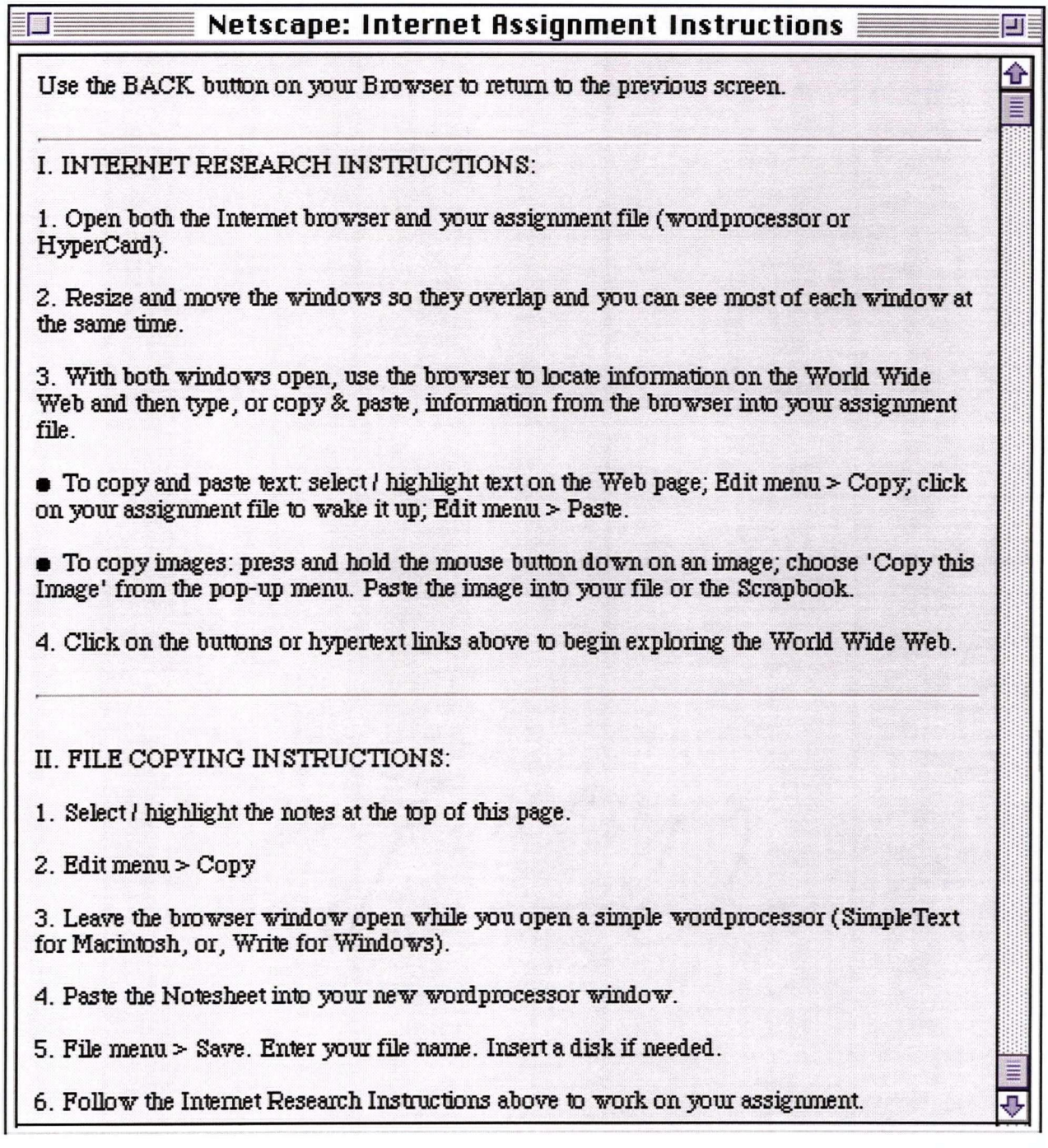


Figure A3.6 - Internet Research Instructions Page



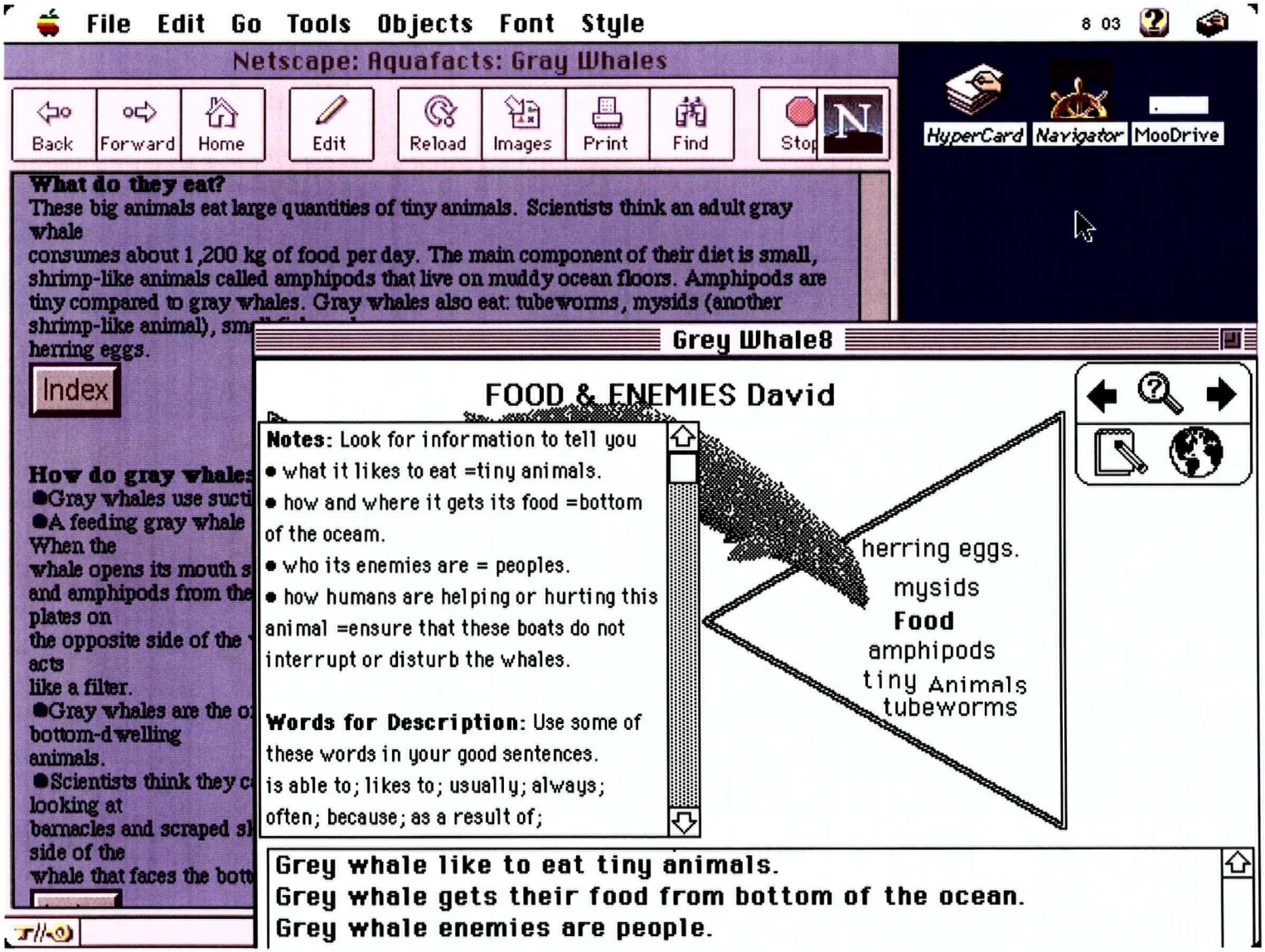


Figure A3.7 - Students' Digital Environment