

Shedd Educational Adventures
Summative Evaluation
John G. Shedd Aquarium

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
OVERVIEW	4
EVALUATION BACKGROUND.....	4
Methodology	5
Methods	6
Data Analysis	7
Data Citations	7
Limitations	8
RESULTS	9
Teacher Experience	9
General Experience	10
Contribution to Professional Development	17
Technical Issues	18
Enjoyment.....	19
Reactions to the Evaluation Process	20
Student Experience	21
How Students Used <i>SEA</i> Resources/Activities.....	22
How Students Engaged and Interacted with the Interactive Modules	23
Contributions to Student Learning and Performance.....	28
Students' Reactions to <i>SEA</i>	33
CONCLUSIONS	39
Factors that contributed to a successful experience with <i>SEA</i>	39
Factors that detracted from a successful experience with <i>SEA</i>	40
RECOMMENDATIONS.....	42
REFERENCES CITED	45
APPENDIX A: TOPICAL FRAMEWORK	46
APPENDIX B: INFORMATION ABOUT RESPONDENTS.....	48
APPENDIX C: SAMPLE PROTOCOL FOR IN-DEPTH INVESTIGATIONS	49
APPENDIX D: SAMPLE PROTOCOL FOR INTERVIEWS.....	53
APPENDIX E: ON-LINE SURVEY QUESTIONS	55
APPENDIX F: STUDENTS' ADVICE ABOUT <i>BUILD-A-FISH</i>.....	58

EXECUTIVE SUMMARY

Introduction

The John G. Shedd Aquarium (Shedd) developed the Web-based *Shedd Educational Adventures (SEA)*, based on Shedd's *Wild Reef* exhibition, in order to provide usable Web-based resources for K-12 teachers. The *SEA* modules included (1) a lesson plan database for teachers, (2) interactive student activities, and (3) an Explorer's Guide (55 cultural and animal fact sheets in English and Spanish). As part of the development process, Selinda Research Associates, Inc. (SRA) worked with Shedd to plan and oversee a summative evaluation of *SEA*. The primary purpose of this summative evaluation was to learn about the ways in which and the extent to which the *SEA* project met its goals.

Methodology and methods

Selinda Research Associates used its expertise in informal learning and naturalistic methodology to perform this evaluation. The goal of naturalistic methodology is to provide a holistic understanding of a subject from a variety of perspectives. To help ensure variety among respondents, we used purposive sampling to select teachers and students. Because purposive sampling deliberately selects respondents (i.e., the sample is not randomly generated), percentages are not used in results. Observation and interview data were analyzed using inductive constant comparison (Lincoln & Guba, 1985), whereby each unit of data is systematically compared with each previous unit of data.

The focus of the *SEA* project was to assist K-12 teachers in teaching about aquatic science, so our evaluation primarily concerned teachers' experience using *SEA* resources in their classrooms. A secondary focus was students' experiences with the activities. The data in this report came from three main sources: (1) multiple in-depth investigations with five select classes in Chicago-area schools during May and June 2003, in which SRA observed and talked with 107 students and 8 teachers; (2) depth interviews with four additional teachers during June and July 2003; and (3) observations of five students using the *Mysteries of Apo Island* or *Build-a-Fish* interactives at home.

Results

Based on this study, *SEA* provided teachers and students usable and useful resources for learning about aquatic science. We heard reports of and saw these resources used as effective supplemental activities to existing marine science and general science curricula. The following section highlights some of the major findings of this study. As this is only an overview, we refer the reader to the full report for a detailed discussion of the results.

- The teachers we talked with were excited by the *SEA* resources and said they looked forward to using them in the future. Many mentioned a constant need for high-quality interactive materials, such as those provided by *SEA*, for their students. Many teachers said they would like more on-line resources such as the ones provided by *SEA*.
- Most of our teacher respondents started from the CD-ROM mailed to the schools. Some teachers said that even if they had not received the *SEA* CD-ROM, they assumed that they eventually would have located the *SEA* resources because they (1) search the

Web for new resources every year, (2) visit Shedd's Web site prior to their annual field trips to the aquarium, and/or (3) exchange resource ideas with other teachers.

- Teachers could pick and choose *SEA* modules to use in their classrooms in the manner that they thought best suited their students. In some cases, teachers chose an interactive as a supplement to a lesson, while in others, they adapted the Explorer's Guide to a classroom activity. Teachers could successfully use these resources in their classrooms without adopting an entire lesson plan. From our front-end evaluation, we know that teachers do not take entire lesson plans from other sources, so a resource that doesn't expect or force teachers to do this would be more useful.
- Most of our respondents used the interactives, but for several reasons none used the lesson plans. Some of the teachers started with the CD-ROM and hadn't looked at the Web site, so they didn't know the lesson plans existed. (The lesson plans were not available on the CD-ROM sent to the schools.) Some teachers said that they usually created their own lesson plans instead of using someone else's. These teachers said, however, that while they may not take a lesson plan straight from a Web site, they liked to see them in order to find new activities and ideas when developing their own plans. A few teachers said the lessons weren't appropriate for their students, because their students already understood the concepts. These teachers didn't review the more advanced resources (either lesson plans or interactives), suggesting that a search by grade level may limit teachers' understanding of what is available on the *SEA* Web site.
- The concepts covered by the *SEA* resources were general enough that teachers could integrate the resources with their varied curricula. For example, some teachers used the resources to teach about ocean life, while others used them to supplement units on vertebrates or animals in general.
- The *Squish the Fish* and *Build-a-Fish* interactives and the Explorer's Guide didn't require teachers to invest in extensive preparation before using them. The two interactives were intuitive enough that teachers could run through them quickly in order to ascertain whether they would function, without modification, as appropriate supplemental activities for their students.
- On the whole, the students seemed able to use the resources on their own, with some one-on-one (or one-on-small-group) support from their teachers.
- The interactives were more effective when teachers related them to a curriculum unit on the same or a related topic. In these cases, the students often had background knowledge about the animals and about the concepts behind the games. In addition, the teachers took time to introduce the games and to discuss them after the students had played them one or more times.
- Based on this study, *SEA* did not significantly impact teachers' professional development, mainly because the majority of teachers we talked with already used the Internet for teaching and lesson preparation and already incorporated diverse activities into their science teaching.

- With *Squish the Fish*, students seemed to recall and rehearse ideas they had learned before and sometimes developed new ideas. They also learned the names and something about the behaviors of the animals. With *Build-a-Fish*, students seemed learn about the complex interrelationships between physical adaptations and behavior, and were sometimes able to generalize what they had learned.
- The *Squish the Fish* and *Build-a-Fish* interactives were especially effective for those students able to play them multiple times over the course of a few months. These games engaged most students on multiple intellectual, physical, and social levels. A number of qualities contributed to the interactives' success both as learning tools and as enjoyable games, most notably the games' playfulness, their ability to encourage social interaction, and the level of challenge they presented to the students. Not surprisingly, most of the students we observed connected to the interactives most strongly as hands-on, experiential experiences.
- For the most part, respondents playing *Mysteries of Apo Island* learned facts and practiced skills such as reasoning, observation, and note taking. The *Mysteries of Apo Island* interactive appeared to have less of an impact on students' learning than the other interactives. This finding, however, was based upon respondents playing the game at home without support from a teacher. For example, a discussion before, during, or after the interactive sessions would almost certainly help students recall more facts about the game and expand the learning into concepts.
- The students' experience with the Explorer's Guide seemed mostly to involve learning facts about specific animals. The students we observed seemed to find these facts interesting and most of them engaged with the task for the entire hour.
- The games worked well when played on relatively new computers, either from the CD-ROM or over a fast Internet connection.
- Negative aspects of the *SEA* resources tended to center around technical problems (e.g., screen sizes, not having Flash installed, etc.) and design issues (mostly text readability). *Mysteries of Apo Island* was difficult for some respondents to play successfully as a standalone activity at home because of unclear instructions, difficulties manipulating game elements, and the limited responses of Dr. Fisher.

Conclusions

Overall, *SEA* was successful in meeting its goal to provide usable Web-based resources based upon Shedd's *Wild Reef* exhibition for K-12 teachers. Moreover, the teachers and students we talked to and observed had positive experiences using the resources.

In the full report, we discuss the findings highlighted above and provide recommendations for future revisions.

OVERVIEW

The John G. Shedd Aquarium (Shedd) developed the Web-based *Shedd Educational Adventures (SEA)* in order to provide usable Web-based resources based upon Shedd's *Wild Reef* exhibition for K-12 teachers. Approximately 20 project teachers (10 from the Chicago area and 10 from central and downstate Illinois) assisted Shedd during the development phase of *SEA*. The Web site was launched in January of 2003. The modules of *SEA* included (1) a lesson plan database for teachers, (2) interactive student activities, and (3) an Explorer's Guide (55 cultural and animal fact sheets in English and Spanish).

The primary audience for these resources was Illinois K-12 teachers and their students. The secondary audience consisted of teachers and students elsewhere in the country, and beyond, who find the resources and activities valuable. The lesson plans were designed for teacher use; the multimedia interactives were primarily for student use. It was intended that teachers would use the lesson plans and supporting resources to aid in their lesson preparation, and that students would use the on-line multimedia activities in conjunction with teacher-led lessons. The overall learning goals for the lessons and activities covered a range of topics, including evolution, adaptation, and conservation as they concern fish, coral reefs, and general marine science. Each lesson and on-line activity also had particular learning goals.

EVALUATION BACKGROUND

As part of this development process, Selinda Research Associates, Inc. (SRA) worked with Shedd to plan and oversee a summative evaluation of *SEA*. The primary purpose of this summative evaluation was to learn about the ways and extent to which the *SEA* project met its goals. The summative evaluation also identified areas where improvements can be made to the resources. This report describes the findings from this study.

The overall research questions were:

- To what extent and in what ways do the on-line resources contribute to teacher knowledge, skills, and/or approaches to learning and teaching?
- To what extent and in what ways do the on-line resources affect student performance and learning?

As part of this process, we developed a topical framework in collaboration with the Shedd team that outlines the specific issues that we explored. The Topical Framework is included as **Appendix A**.

Methodology

Selinda Research Associates used its expertise in informal learning and naturalistic methodology to perform this evaluation. The goal of naturalistic methodology is to provide a holistic understanding of a subject from a variety of perspectives. Naturalistic inquiry is a rigorous approach to understanding experiences in the natural context in which they occur. It usually includes collecting data from a variety of sources and triangulating that data to develop a thorough understanding of the subject of investigation (Miles & Huberman, 1994).

This approach to user research is particularly useful in a setting such as Shedd's *SEA* because teachers and students will be coming to it with varied experiences, interests, and levels of knowledge. Rather than looking for an "average" experience, naturalistic inquiry aims to describe the *range* of experiences and understandings. As such, it is a powerful tool for developers concerned with reaching complex audiences.

Naturalistic inquiry relies to a large extent on qualitative data. One strength of naturalistic evaluation is that unanticipated findings can emerge from the data, often in respondents' own words. This type of inquiry allows for the researcher to follow up on threads and themes that characterize how respondents think about their experiences. This approach also allows the development team to develop a rich understanding of the ways in which users may react to and use the resource.

Respondents

We used purposive sampling methods in selecting respondents for this study (Miles & Huberman, 1994). In purposive sampling, each respondent is handpicked for certain characteristics. The goal is to talk with respondents who are as different from each other as possible in order to elicit the widest possible range of responses. Because purposive sampling deliberately selects respondents (i.e., the sample is not randomly generated), percentages are not used in results.

SRA and Shedd staff collaboratively determined criteria for selecting teachers and students who would serve as respondents for this study, including:

- Pre-selected grade ranges
- Mix of urban and suburban schools
- Mix of respondents who had previous experience with *SEA* and those who did not

Shedd and SRA staff worked together to locate teachers who fit within these pre-determined categories and who would be willing to participate in the study. We offered our respondents confidentiality during our observations and interviews. Therefore, we do not use individuals' names or schools in this report. All respondents received Shedd thank-you packets for their participation. Information about the respondents is included in **Appendix B**.

Methods

General approach

The focus of the *SEA* project was to assist K-12 teachers in teaching about aquatic science by providing them lesson plans, interactives, and worksheets via the Web. We extensively studied the teachers' use of the Web site and students' use of the interactives during the formative evaluation stage of the process. For this reason, the summative evaluation primarily focused on the teacher experience with using *SEA* resources in their classroom. A secondary focus was the students' experiences with the activities.

In-depth investigations with select classes

SRA conducted multiple in-depth investigations with select classes in order to understand how teachers and students were using *SEA* as well as the influence of the resources and activities on the classrooms. These investigations took place during May and June 2003.

When possible, we conducted initial and follow-up telephone interviews with each teacher. The purpose of the teacher interviews was to understand to what extent and in what ways the resources contributed to their knowledge, skills, classroom organization, and/or approaches to learning and teaching. These depth interviews, which were unstructured and open-ended, yielded rich descriptive data in respondents' own words and allowed researchers to explore questions in a depth not usually possible with quantitative research.

These investigations also involved observations of classes as *SEA* resources were being used. The purpose of the observations was to see how teachers integrated *SEA* into their lessons in live classroom settings. In addition, we were able to observe students interacting with *SEA* in order to understand what they gained from using the activities.

The classrooms we observed included:

- Combined Kindergarten and first grade at a Montessori public school
- Combined second and third grade at a Montessori public school
- Third grade in a public school
- Third grade in a public school with eighth graders working to mentor the third graders
- Fifth grade working together with fifth graders from a combined fourth-fifth grade class in a public school

Two of the classrooms we observed were in a Chicago Public School. The other classes were in the Chicago suburbs. A total of 107 students and 8 teachers participated in these in-depth investigations. See **Appendix C** for a sample protocol for the in-depth investigations.

Interviews with additional teachers

SRA conducted in-depth telephone interviews during June and July 2003 with teachers who had used *SEA* resources, but who were unable to participate in our observations. The purpose of these interviews was to triangulate the data from the classrooms we investigated, to get a sense of the breadth of teacher experiences, and to obtain feedback from grade ranges that were not represented in the classroom observation sample. Through our interviews, we intended to evaluate the ways and the extent to which these teachers were able to integrate *SEA* into their curriculum. We also wanted to learn the ways in which and

the extent to which the resources were perceived to have affected both the teaching experience and student learning. A total of three teachers participated in these interviews. The interviews were taped and transcribed. See **Appendix D** for a sample protocol for the in-depth interviews.

Because of the timing of this evaluation, we were unable to recruit middle school teachers who had used the resources in their classes. Instead, we observed and interviewed a middle school teacher/librarian reviewing the *SEA* Web site. The purpose of this review was to identify both positive and negative aspects of the resources.

Observations with additional students

Due to the timing of the study (which came at the end of the school year), we were unable to observe students using *SEA* in middle school or high school classrooms. We observed three middle school students using *The Mysteries of Apo Island* in their own homes in order to gain some understanding of the interactive experience. These observations took place in July 2003. One of these students had an elementary school sibling who also played the game while we observed. In addition, we also observed a second grader playing *Build-a-Fish* at home.

On-line survey

As part of this evaluation, SRA also assisted Shedd in the development of questions for an on-line survey of *SEA* users. The purpose of this survey was to perform ongoing evaluation of *SEA* and obtain continuous feedback about the function, structure, and content of *SEA* that can then be used to improve the site beyond the duration of the grant. Because the survey was not intended to be on the Web site when this report was written, the survey results will not be discussed in this report. However, the survey questions may be reviewed in **Appendix E**.

Data Analysis

Observation and interview data were analyzed using inductive constant comparison (Lincoln & Guba, 1985), whereby each unit of data is systematically compared with each previous unit of data. In constant comparison, concepts emerged from data units and then were elaborated or modified by the researcher as incoming data were meticulously compared to previous data units. This allowed us to continually identify, develop, and refine categories of data and identify interesting themes as they emerged.

Data Citations

We used specific conventions in this report when citing our data. The numerals of the citation indicate the date of the contact and the group number of the respondents. For example, a quotation marked “(053003-1)” is from the first group we talked with on May 30, 2003.

Limitations

Due to limited resources and tight timelines, this study was necessarily limited in scope. When conducting an evaluation study using naturalistic methodologies, it is standard practice to continue collecting data until a *state of redundancy* is reached. Redundancy is the point at which no new information is gleaned despite repeated attempts to elicit additional findings. We have achieved redundancy on many of the issues we listed in the topical framework. However, we were not able to reach a state of redundancy with *all* aspects of this study.

The timing of the study limited the number of teachers we were able to interview. Because the study began in March 2003, many teachers' hectic end-of-year schedules did not allow them to participate. In addition, many teachers had already taught their most closely related curricula earlier in the year. Our previous work with teachers suggests that, although the general outline of their curricula and many of the specifics often are established early in the year, many teachers continue to search for and, when appropriate, adopt new resources that fit their plans. The *SEA* resources were not available to teachers until January, mid-way through the school year, and we were not able to contact teachers until even later in the year.

In spite of this timing, we were still able to locate a number of teachers who had begun using the CD-ROM or on-line materials within pre-planned units on oceans or vertebrate life. However, we experienced difficulty in finding teachers who had integrated the resources (especially the lesson plans) into their curricula at certain grade levels, including the K-2, middle school, and high school levels. While we were constrained by the grant timeline during this study, we would recommend that future studies utilize a timeline that makes materials available starting in mid-July as well as a summative evaluation beginning in the middle of the school year (or earlier). This would increase the number of teachers available for participation in evaluation of the program.

RESULTS

This study revealed that the *SEA* resources provided teachers and students with useable and useful resources for learning about aquatic science. We heard reports of and saw these resources used as effective supplemental activities to existing marine science and general science curricula. In the following sections, we describe the nature of both the teacher and student experience with *SEA*.

In naturalistic evaluation, we describe the range of experiences rather than the percentage of people that acted or thought a certain way. Because respondents were purposively selected, it is inappropriate to report the percentages of respondents who felt a particular way. Instead, we identify which views were more commonly held and which were more idiosyncratic.

Throughout this study, we have included comments from respondents, when appropriate, to illustrate various points. It should be understood that the number of quotes selected is not representative of the number of respondents who expressed a particular sentiment. When selecting quotes to use, we chose ones which were clearly stated and that illuminated a *range* of respondents' perspectives.

Teacher Experience

We evaluated the teacher experience with *SEA* in four main areas: (1) the general experience with *SEA* (i.e., finding the materials, choosing them, preparing to use them, and using them), (2) the resources' impact on teachers' professional development, (3) the technical issues teachers encountered, and (4) the enjoyment the resources provided teachers. Overall, the teacher experience with *SEA* resources was positive. The teachers we talked to thought that *SEA* was a valuable addition to their teaching resources. As with any project, there is room for improvement in some aspects of the resources, notably the alignment of the lesson plans and Explorer's Guide with grade levels, errors in the Explorer's Guide and lesson plans, and a small number of technical difficulties.

The teachers we talked with were excited by the *SEA* resources and said they looked forward to using them in the future. Many mentioned a constant need of high-quality interactive materials for their students and said they would like to see more on-line resources like the ones provided by *SEA*. For example, one respondent said:

As a librarian, I'd recommend it [SEA] to other teachers. The interactive part is such a good hook for the kids....Most of the stuff out there is bad. Even on museums [Web sites] it's like page-turners.... there aren't that many good interactive sites out there. (071603-1)

Another explained why she used on-line interactives:

I tend to write my own lessons. I tend to plan my own activities, in terms of how much time I want to spend on something. But I do like interactive sites [where]...students can relearn or reinforce concepts in a different way. (061503-1)

Based on this study, *SEA* did not have a significant impact on teachers' professional development. The majority of teachers we talked with already used the Internet for teaching and lesson preparation and had already incorporated diverse activities into their science teaching. Therefore, access to the *SEA* resources didn't prompt a major change to our respondents' approaches to teaching and learning. The timing of launch of the *SEA* resources and its subsequent evaluation also might have affected this finding. Most respondents (and many other teachers we contacted but who declined to participate in the study) had limited experience with *SEA*. If teachers had had more time to familiarize themselves with the resources, and to integrate them into their curricula earlier in the year, we may have found that the resources had a larger impact on teachers' knowledge and skills as they related to these specific subject areas.

The following section discusses our findings in detail.

General Experience

Finding and Choosing SEA Materials

Among our teacher respondents, most started from the CD-ROM mailed to the schools.

- Four teachers had started to use the games in their classrooms after **receiving the *SEA* CD-ROM and information packet**.
- Four teachers were **informed about the *SEA* Web site by colleagues** (other teachers in the sample).
- One teacher had **participated in formative testing** of the *Build-a-Fish* game, and had subsequently used the game as part of a unit on ocean life.
- One teacher had been **involved in the development of *SEA* at Shedd**.
- The middle school teacher/librarian learned about the Web site when she was contacted for this study.

Some teachers said that even if they had not received the *SEA* CD-ROM, they assumed that they eventually would have located the *SEA* resources because:

- They still **search the Web for new resources** every year (even though they may not find much new material they can incorporate into their existing lessons).
- They **visit Shedd's Web site prior to their annual field trips** to the aquarium.
- They continue to **exchange resource ideas** with other teachers in their districts.

Range of Resources Used

Most of our respondents used the interactives, but none used the lesson plans. All teachers we observed had their students play the games—either *Squish the Fish* or *Build-a-Fish* (or both, depending on their grade level).

The Explorer's Guide was used by only one of the classrooms in the study. The fifth grade teachers developed a lesson based on the on-line version of the Explorer's Guide. The objective was to read the animal information sheets from Shedd's *SEA* Web site, then write trivia questions to be used in a game or contest a few days later. [Note: The school year ended before they could have the contest.]

Of the teachers we interviewed, but did not observe, one had her students use the interactive *Conservation Investigation: Seaborses*, one showed his students the Web site, and one reviewed the Web site herself.

There seemed to be several reasons why no one used the lesson plans.

- Some of the teachers **started with the CD-ROM and hadn't looked at the Web site** when we first talked to them, so they didn't even know the lesson plans existed as they were planning what to do with the resources. (The lesson plans were not available on the CD-ROM sent to the schools.)
- The two fifth grade teachers looked at the lesson plans and decided they **weren't appropriate for their students**, because their students already understood the concepts.

It seems the printing of the fish [Something Fishy lesson plan], too, I think that's...more a primary concept than intermediate concept....I think our kids are beyond that. It might be a fun activity that we might do. But as far as an objective to be learned from that, I'm not quite sure if that's—we would use it for that. (053003-1)

These teachers didn't review the more advanced resources (either lesson plans or interactives), suggesting that a search by grade level may limit teachers' understanding of what's available on the *SEA* Web site. For example, the results of searching the lesson plans for fifth grade show grade 5 as the upper limit for three lessons with no lessons where grade 5 is at the lower limit. Perhaps this issue will resolve itself when more lessons are put on-line.

- We also spoke with a combined K-1 teacher who said the lesson plans were **too advanced for her students**. Finding grade-appropriate lesson plans seems to be an issue with certain grades, at least for this group of teachers. (Note: All lesson plans were pulled from paper activity guides that had been extensively tested with appropriate age groups listed with the lesson plans. These earlier tests involved a larger number of testers than we were able to use in this study.) As we noted during front-end evaluation, the proper assignment of grade levels seems to be a very important issue with teachers.
- Finally, some teachers said that they usually **created their own lesson plans instead of using someone else's**. This is consistent with what teachers told us during the front-end evaluation. However, these teachers also said that while they may not take a lesson plan straight from a Web site, they liked to see them in order to find new activities and ideas when developing their own plans.

Using SEA Resources

In all the classrooms we observed or whose teachers we interviewed, students used the resources on the computer (rather than as part of a lesson or activity presented in front of the class or completed in small groups).

- In three classrooms, **small groups of students used the games with minimal supervision** as a supplement to their normal classroom work.
- In the other classrooms, the **whole class used the resources simultaneously**, either in the computer lab or library, or at clusters of computers scattered throughout the large, open classroom. In some classrooms each student had a computer, but in others several students shared one.

- In the high school class that used *Conservation Investigation: Seahorses*, the teacher had her students perform the activity **independently**.

Student use of SEA resources is discussed in more detail later in this report.

Integration with Curriculum

Most of the teachers observed found ways to integrate the resources with their curricula.

- Four teachers **incorporated the SEA materials into units they were already teaching** on ocean life. For these classes, the concepts related to camouflage and adaptation; the examples of reef animals and reef habitats fit extremely well with what they were teaching. Below are some teachers' comments about how the resources fit into their curricula:

Our underwater unit is a pretty drawn-out unit....The Build-A-Fish is really just one component of it. (052303-1)

When we're doing our underwater unit... [and] in other times during the year, too, we talk about animals' environments and how animals are suited to their environment....So, we do talk a lot about...the three things that Build-a-Fish talks about. You know, what's its body shape? What's its color? Does it blend it? Does it not blend? ...And then, talking about the mouth....looking at a mouth, you can tell a lot about what an animal eats or how it eats or where it has to eat.... actually, we did a lot about teeth earlier in the year, when we talked about...a story we read. Doctor DeSoto. (052303-1)

We do...[a] unit on ocean study at the end of the year. And the resource part of an SEA project is what we really have found to be most valuable. So, they'll come into this with already a little bit of knowledge. And so, they'll be looking for specific things to...create in their questions that they'll be asking the entire group. (053003-1)

- Two teachers used the games to **supplement an extended unit on a related subject**. One teacher used the interactives to supplement a unit on vertebrates. Although the unit on fishes had been a few months earlier, she had her students play both *Squish the Fish* and *Build-a-Fish*. During a subsequent discussion, she related the concepts of camouflage and adaptation to a range of vertebrates that students had studied that spring. Another teacher used them to supplement a unit on animals in general. His students were required to write a year-end report on an animal of their choosing, and fish were a potential subject. *Squish the Fish* and *Build-a-Fish* served to reinforce a lesson on fish anatomy and adaptation. This class was also scheduled to visit Shedd two weeks after our observations.
- In the high school class, *Conservation Investigation: Seahorses* was used as **to culminate a unit** on ecology.
- Another teacher was **currently studying an unrelated subject** (insect life) with her students, but she allowed her students to play *Squish the Fish* in small groups as a favor to Shedd Aquarium.

In addition, various teachers and students told us that some students had **played the interactives at home** by either borrowing the disk or accessing the Web site. Also, teachers

pointed out that they could use the games as **educationally valuable “time fillers”** for students to use, on their own, once they had finished their current assignments.

Adapting and Supplementing SEA Materials

Resources were used uniquely in each classroom.

- The two fifth grade teachers developed an approach to the Explorer’s Guide that was **an adaptation of the resource** to meet their own needs.
- One third grade classroom played *Build-a-Fish* as an **introductory activity to a previously developed unit** on ocean life.
- In another third grade classroom, the teacher viewed *Build-a-Fish* as a **summary activity added to an existing unit** on ocean life. Similarly, as mentioned above, the high school teacher used *Conservation Investigation: Seahorses* to wrap up an ecology unit.
- In the grade 2-3 classroom, and in another grade 3 classroom, *Squish* and *Build-a-Fish* were **supplements, loosely related** to the current course of study.
- In the grade K-1 classroom, *Squish the Fish* was a **stand-alone activity, unrelated** to the current course of study.

Preparing to Use the SEA Resources in the Classroom

The teachers whose classes we observed did minimal preparation before using *SEA* resources.

- The fifth grade teachers **prepared a handout** for the trivia questions activity.
- For the most part, teachers who only used the interactives did **little preparation**.
- In the high school class, the teacher **created step-by-step instructions** to help her average- to low-track class understand up front what they were going to do (e.g., read this, look for multiple reasons for the seahorse’s decline, go to these links, etc.).
- The K-1 teacher **arranged to have a projector** attached to her computer so she could step the children through *Squish the Fish* the first time.

The *Squish the Fish* and *Build-a-Fish* interactives were intuitive enough that teachers could run through them quickly and ascertain their functionality, without modification, as appropriate supplemental activities for their students. Based on our earlier front-end evaluation of *SEA*, and comments from teachers we interviewed, we anticipate that more preparation would be involved if a teacher chose to use a lesson plan; teachers would have to ensure in advance that the lesson would work smoothly, and probably modify it substantially (or only select some aspects of it) for use in their classroom.

How Teachers Assisted Students with the Activities

Most teachers we observed introduced the activities, and some held a group discussion afterwards. In the case of the joint third/eighth grade class, eighth graders were responsible for presenting a lesson to their third grade groups. Other than that, the students seemed to be able to use the resources on their own, with some one-on-one (or one-on-small-group) support from their teachers.

- The fifth grade teachers gave a **brief introduction** (about five minutes) to the material, passed out the handouts and group assignments, and then allowed the students to use the interactive on their own. The teachers were then available to **answer questions, trouble-shoot problems, help students develop their questions, and keep them on task** as they completed their work.

- The K-1 teacher used a projector attached to her computer in order to walk the children through *Squish the Fish* the first time. A child used the mouse while she **guided them through the activity**. (This report is from the teacher, as we were not in the classroom.)
- The third grade teacher we interviewed said she **introduced the activity by talking about concepts**, including (1) different kinds of fish and how they avoid predators and seek out prey; (2) coloration; and (3) different zones in the ocean.
- In one classroom, a third grade teacher and her assistant were available to **answer questions, trouble-shoot problems, and keep students on task** as they played *Build-a-Fish* and completed their assignment. (Her students had been introduced to the activity in November.)
- The combined second-third grade teacher was too busy (and perhaps not knowledgeable enough) to offer much support to her students, at least while we observed. However, after students had used the games, the teacher **held a group discussion** where students voiced what they liked and disliked about the games and how the games related to what they had learned about adaptation in general and about predators and prey during their extended unit on vertebrates.
- In the combined third-eighth grade class, the two teachers **managed classroom logistics related to the activity**—organizing groups of students, placing them in separate areas to work, directing them to the computer lab, helping them find computers, and suggesting what the students could do once they completed the interactive.
- The high school teacher we interviewed did not report any additional assistance given to her students other than **providing more detailed instructions** for the seahorse activity.

Teacher Reactions to Lesson Plans

Since no teachers in this sample used the lesson plans, we cannot address the specifics of a successful lesson plan. However, we did learn some things about the lesson plans during this study:

- Most teachers were familiar with range of Shedd’s educational offerings, and some of them said they wished the lesson plans had included **links to off-line resources** such as Discovery Boxes, aquarium exhibits, and tours.
- **Answer keys for the printable student worksheets**, such as the worksheet included with “Something Fishy,” would help teachers feel better prepared in front of their students.
- **On-line quizzes** would enable students to test themselves and to reflect on what they have learned. Some teachers mentioned BrainPop.com as an example of appropriate use of on-line quizzes linked to educational content.
- Some teachers who reviewed the lesson plans pointed out several instances where **files had been omitted and/or text had been poorly edited**. While Shedd has moved to address these issues, it is important to include adequate time for editing and proofing lesson plans in future timelines.

The following are additional lesson plans the teachers said they wanted to see Shedd place on-line or on CD-ROM:

- Similar resources developed for **other aquatic habitats and/or ecosystems**, including Illinois rivers, the Amazon, and the deep sea. Some teachers said they liked the idea of coordinating Web offerings with exhibits they could visit with their classes.

- Resources on **ocean exploration**.
- **Conservation-related lessons and activities** for elementary students, including backyard conservation projects with freshwater habitats.
- **Interdisciplinary lesson plans** that included information about stories and novels related to the Philippines.

Other On-Line Features Desired by Teachers

The teachers also mentioned the following other features they would like Shedd to put on-line or on CD-ROM:

- Several teachers had used and/or developed **Web Quests** with their students, and they seemed a bit surprised that Shedd's site didn't include them.
- Some teachers said they wanted the *SEA* site to include features that would help **prepare their students for a tour of Shedd's exhibits**, including maps of the building and other materials they could easily modify for their own trips and worksheets. (Trip planning material may be somewhere on the *SEA* site, but we couldn't find it in 10 minutes of searching.) Such offerings might help reduce the novelty of Shedd's environment to an acceptable level. For a short summary of the effects of too much novelty on student learning during field trips to museums and zoos, see the following Web site: <http://www.astc.org/resource/educator/ftrips.htm>.
- K-3 teachers said the text in the Explorer's Guide was too challenging for their students, and that there was a real need for similar **on-line information sheets developed for beginning and early readers**.
- The high school teachers we talked with were pleased to see *SEA* activities for their students and would like **more high school level resources** added. Both teachers said that it was time-consuming to find appropriate resources for high school students on-line.
- The middle school teacher/librarian we spoke was especially happy to see the Spanish language Explorer's Guide. She explained:

I think it's really wonderful that it's in Spanish....As a school librarian, I have such a hard time finding good quality materials in Spanish . . . in non-fiction.... so this is fabulous. (071603-1)

She said she searches for Spanish materials written at an appropriate (i.e., not primary) grade level for her students who speak English as their second language. She also said that **interactives in Spanish** would be useful in her school, which has a large population of new immigrants.

Factors Contributing to the Success of the Student Activities

Based on our observations and interviews, a number of factors seemed to contribute to the success of the interactives:

- ***Squish-the-Fish* and *Build-A-Fish* were fun enough that most students wanted to play them repeatedly.** When teachers allowed students to use the games several times over an extended period, the games held interest until students mastered the games themselves and some of the concepts behind the games.
- **When used by students at the suggested grade levels, the games generally presented an appropriate level of challenge.** For some younger students, the challenge level sometimes led to frustration, while some older students said they became

bored because the games were too easy. Overall, however, the fun factor kept most students on task until they mastered even the frustrating aspects of the game.

Surprisingly, we found that most third graders were not bored playing *Squish the Fish*, even though it was designated as a K-2 game.

- **The interactives were more effective when teachers related them to a curriculum unit on the same or a related topic.** When this was true:
 - The students more often had some **background knowledge** about the animals and about the concepts behind the games.
 - The teachers took time to **introduce the games and to discuss them after** the students had played them one or more times.
- The games worked well when played on **relatively new computers from either the CD-ROM or over a fast Internet connection.** The teacher who tried to use the games on older computers couldn't get the games to load (probably because she didn't have the Flash plug-in installed).

What Was Missing from the Student Activities

Based on teachers' comments and our observations, the following seemed to be missing from the student activities:

- **An effective way to provide technical help for teachers who don't have Flash installed on their computers.** (See below.)
- **A warning about slow download times for users who access the games on-line with a dial-up modem.**
- Some teachers said they wished the game intro pages had included **links to off-line resources** such as Discovery Boxes, aquarium exhibits, and tours.
- **Alternative ways for students to review and reflect on what they have learned (for when teachers are unable to hold post-game discussions).** Some teachers suggested **on-line quizzes** to test students on what they have learned.

Issues Related to the Explorer's Guide

Both teachers and students who used the Explorer's Guide pointed out several instances where **the text needed further editing and proofreading.** The fact that this site is aimed at teachers makes this issue particularly important.

How SEA's Affiliation with Shedd Affected Teachers' Perceptions of the Site

All the teachers we talked with expressed very positive feelings about Shedd. That probably helped us recruit them to participate in the study, and it also seemed to add to their feelings about the value of the Web site. In addition, most of these teachers also visited Shedd with their classes, and the strong links between Shedd exhibits and the *SEA* resources seemed to be valued by these teachers.

How SEA May Affect the Use of Other Web Sites by the Teachers

Based on our interviews, *SEA* may have a slight effect on teachers' use of other Web sites. A few teachers said that they would be less apt to use resources from other ocean-related Web sites, such as Sea World, because they found Shedd's resources to be more interactive and more appropriate for their needs. One teacher explained:

I just think it's [SEA's] another good resource. I think everyone who gets involved and puts more on this Internet is doing a great service to the teachers. I don't have time to create my own all the time. (061503-1)

Since most of these teachers were veteran Internet users, they didn't imagine being any more or less apt to use the Web because of their experiences with *SEA*. One teacher did say he didn't use the Internet as often as he should because it took him so long to find what he needed, but with *SEA* he'd have "no excuse not to use the Internet" since it offered a variety of good information on one site (061403-1). Two teachers less experienced with the Internet noted how they would try to use the Web more, implying that the positive aspects of their experiences with *SEA* had some influence on their perceptions of the Web as a useful teacher resource. However, many other factors in addition to their experience with *SEA*—factors we could not assess in this limited study—could account for teachers' attitudes toward the Web.

Contribution to Professional Development

One of our overall research questions was "To what extent, and in what ways, do the on-line resources contribute to teacher knowledge, skills, and/or approaches to learning and teaching?" With our teacher respondents, *SEA* did not seem to make a major contribution to their knowledge and skills within these subject areas. However, some teachers seemed to have learned some new facts about individual animals and perhaps deepen their understanding of certain concepts. Based on the short exposure that these teachers had to the *SEA* resources, this finding was not unexpected. We would expect the resources to contribute more to a teacher's knowledge and skills with increased use and deeper exploration of the content.

SEA also didn't seem to prompt a major change to our respondents' approaches to teaching and learning, mostly because the majority of teachers already made extensive use of the Internet for teaching and lesson preparation and were accustomed to teaching activity-based science. In fact, some mentioned that they were excited by *SEA* because they were always looking for good interactive student activities to supplement their classroom teaching. One teacher said,

I would certainly go back to the Web site and look over things...for next year, because it's a good site....Right now, high school teachers are constantly looking for pre-packaged Internet labs. Something different to get students out of a book. (061503-1)

Examination of the *SEA* resources did seem to spark different ideas for using *SEA* both this year and in the future. All of the teachers said they would incorporate Shedd resources in their teaching next year. A few teachers said that next year, as they planned their lessons, they would likely use Shedd's Web site as a primary source—one of the places they would go first. Moreover, many teachers said that *SEA* was the type of high-quality interactive resource that they were always looking for to supplement their curriculum.

It seems that when working with Internet-experienced teachers, it's difficult to change their opinions about the Web. (This does not mean that teachers do not find well-designed on-

line resources necessary for the classroom.) A more appropriate goal for future projects, however, might be to provide high-quality resources and tools which give teachers diverse and unique ways to introduce and reinforce important concepts.

Technical Issues

How Teachers Used the Components of the SEA Site

The teachers used the following components of *SEA*:

- Had their students play the interactives, either on-line or from the CD-ROM.
- Looked at and sometimes used the Explorer's Guide, either on-line or from the CD-ROM.
- Looked at and sometimes reviewed the lesson plans on-line, but didn't use them. Note that teachers who started from the CD-ROM often failed to go to the lesson plans unless we specifically asked them to do so.
- As far as we could tell, none of these teachers downloaded (or even noticed) the Squish Coloring Pages.

Teachers' Use of the Technical Help Function

Most teachers we talked to already had Flash installed on their computers, so they didn't need the Technical Help function. The *SEA* packet mailed to the schools included a page of technical information, but this **quickly became separated from the CD-ROM** (which traveled to classrooms and students' homes without the packet). On the Web site, **the need for Flash was not mentioned**, either in search results or on the pages introducing the interactives/activities.

Our respondent who encountered problems didn't have a clue what was wrong—there was **no useful error message—and didn't think to look for a small link to “Technical Help”** at the bottom of the page. This teacher seemed to need a statement, such as “If you can't get the interactives to work, then go here for help,” placed prominently on the introductory page for the interactives on both the Web site and CD-ROM. Teachers who most need technical help may be the ones least likely to find it given the help function's current configuration.

How the Technology Components Affected Use of the Resources

Due to inadequate technical support, one teacher was unable to use the interactives from CD-ROM on her two older classroom computers. She was also unable to download them at her home.

Other Technical Problems

We encountered a few other technical problems with the *SEA* resources:

- A user who tried accessing the *SEA* site using AOL 7.0 with a dial-up connection received a number of script errors.
- Users who had their monitors set at different screen sizes sometimes encountered difficulties. These will be discussed in the Student section under ***Less Successful Aspects of SEA***.

Enjoyment

Value of SEA Resources for Teachers

The teachers we talked with seemed to consider the *SEA* interactives and, in some cases, the Explorer's Guide, useful additions to their array of classroom resources to teach about ocean and vertebrate life. One teacher explained:

They had an opportunity on Friday to go onto the Web site. And they started out with Squish the Fish and rapidly advanced to Build-A-Fish....So, they found it very exciting. The teachers were just thrilled with it. They thought it really complemented what they teach in the beginning of the year, as far as the parts of a fish, the adaptation that they needed to survive the freshwater coral reef. And it was wonderful. Very motivating. (053003-1)

What Teachers Enjoyed Most about SEA Resources

Because the activities used in our sample classrooms were specifically targeted to students, their enjoyment was more apparent than that of the teachers. Nevertheless, during observations, it seemed to us that the teachers enjoyed watching their students being engaged by resources that related to what they were trying to teach—be they the interactives or Explorer's Guide.

Less Successful Aspects of SEA for Teachers

Overall, there were a few less successful aspects of *SEA* for teachers that might have reduced their enjoyment, including:

- Lack of lesson plans and information sheets perceived as appropriate for their grade level.
- Negative reactions to errors discovered in the Explorer's Guide and lesson plans.
- Technical difficulties that they could not understand or solve on their own (e.g., lack of Flash on their computers).

Reactions to the Evaluation Process

The teacher whose students participated in the formative testing kept referring back to her students' excitement at seeing that "the Shedd" had paid attention to what they said and changed the Web site. She said this seemed to be a unique experience, one that she would recommend to other teachers, but she couldn't think of a way to duplicate it on a year-to-year basis.

Several teachers requested that we send them copies of the final summative evaluation report, which they hoped to share with administrators in their districts.

Student Experience

We evaluated the student experience with *SEA* in two main areas: (1) their learning related to *SEA* and (2) their enjoyment using the resources. Based on this evaluation, *SEA* resources, in particular the interactives *Squish the Fish* and *Build-a-Fish* and the Explorer's Guide, positively influenced our student respondents' understanding of aquatic science concepts.

With *Squish the Fish*, students seemed to both recall and rehearse ideas they had previously learned and, sometimes, develop new ideas. They also learned the animals' names and something about their behaviors. In *Build-a-Fish*, students seemed to be learning about the complex interrelationships between physical adaptations and behavior, and were sometimes able to generalize what they had learned. The *Squish the Fish* and *Build-a-Fish* interactives were especially effective for those students who were able to play them multiple times over the course of a few months. These games engaged most students on multiple intellectual, physical, and social levels. A number of qualities contributed to the success of the interactives—both as learning tools and as enjoyable games—most notably, their ability to encourage social interaction, their playfulness, and the level of challenge they presented to the students. Not surprisingly, most of the students we observed connected to the interactives most strongly as hands-on, experiential experience.

For the most part, respondents playing *Mysteries of Apo Island* learned facts and practiced skills such as reasoning, observation, and note taking. Based on our limited observations, the *Mysteries of Apo Island* interactive appeared to have less of an impact on student learning than the other interactives. This finding, however, was based on respondents playing the game at home without support from a teacher. We anticipate that the interactive would be more effective when used by a teacher as it was intended—as an activity directly tied to a lesson. For example, discussion before, during, or after the interactive sessions would almost certainly help students recall more facts and expand the learning into concepts.

The students' experience with the Explorer's Guide seemed mostly to involve learning facts about specific animals (some of them new to students). The students we observed, nonetheless, seemed to find these facts interesting. Most students engaged with the task for the entire hour.

Negative aspects of the *SEA* resources for students tended to center around technical (e.g., screen sizes) and design issues (e.g., text readability). The following section discusses our findings in detail.

The following section on student experience focuses on elementary and middle school students who we observed using the resources. We interviewed one high school teacher who used the *Conservation Investigation: Seaborses* interactive with her students, but we had to rely on her reporting of the student experience, which limited our ability to analyze that experience in detail. Briefly, this teacher used this interactive as a wrap-up activity for an ecology unit. She said the activity tied concepts together for the students and taught them that there were many reasons for an animal's decline. She said the students were excited about turning in

their articles and especially enjoyed being able to print them in newsletter format. As she explained:

*I would definitely use the seahorse activity again. I liked it....I just think it was easy to follow....It was a good culmination of ecology, because it brought in a lot of the aspects of human impact. And so, I think that was good for them [the students] to see an actual case study that came to life.
(061503-1)*

The only thing she thought would have enhanced the student experience would be movies that showed seahorses in action.

Below are our findings on *Squish the Fish*, *Build-a-Fish*, *Mysteries of Apo Island*, and the Explorer's Guide.

How Students Used SEA Resources/Activities

As noted earlier, in each classroom we observed, students used the resources on the computer (rather than as part of a lesson or activity presented in front of the class or completed in small groups).

- In two classrooms, **small groups of students used the games with minimal supervision** to supplement their normal classroom work.
- In the other three classes, the **whole class used the resources simultaneously**, either in the computer lab or library, or at clusters of computers scattered throughout the large, open classroom. In one class each student had their own computer, but in the other they shared computers and worked in small groups.

Two important trends were related to use of the resources:

- When two or three students used the resources at the same computer, it was a **very social experience**. Many of the social aspects were positive, including sharing of existing knowledge, teaching behaviors, and group problem solving. We also saw, however, a variety of negative behaviors, including fighting for control of the mouse and exclusion of non-group members.
- Four classes in the study **combined younger and older students** in their small groups, at least part of the time. The students in the two fifth grade classes played the games with their 2nd grade computer buddies a few days before our site visit. In the combined K-1 class, the teacher paired first grade students with Kindergartners so that the older students could read to the younger ones. In a third grade class, visiting eighth graders acted as mentors as the younger students used the interactives.

With regard to the sound/no sound option on *Squish the Fish*, in two classrooms that we observed, the small groups of students who played this game had the sound turned off (so as not to disturb others in the classroom), and one or more students read the narrative aloud. The second graders who we observed were fairly fluent readers, enough so that the experience of the *Squish the Fish* narrative did not seem diminished by their having to read it aloud. In the combined Kindergarten–first grade groups, the first graders who read the text were less fluent, and the narrative experience was greatly diminished, both because their reading was rather slow and because they often skipped large sections of text.

The few respondents who we observed playing *Mysteries of Apo Island* did so at their homes, primarily as a solitary activity. In one case a sibling was present, but primarily as a spectator. In another, a sibling more actively helped the respondent play the game. In all cases, the interactive was not presented as part of a school unit or lesson.

How Students Engaged and Interacted with the Interactive Modules

We found at least three profitable ways of looking at student engagement and interaction with the interactive modules: types of engagement, entry points, and intrinsically motivating experiences. The first approach is descriptive; the second is based on Howard Gardner's theory of multiple intelligences (Gardner, 2000); and the third looks at the motivational aspects of experiences.

Types of engagement

Research across a range of media has shown that it is particularly useful to study three types of interactions between users and an educational activity: physical, social, and intellectual (Perry, 1989, 1993). **Physical interactions** refer to those things the user actually does, especially compared to the development team's intentions. It includes whether or not respondents use the activities in the ways they were intended, as well as the extent to which they use them meaningfully. **Social interactions** include spontaneously occurring conversations among users which can be assessed for meaningfulness. "Meaningfulness" refers to a variety of criteria including relating what users are doing to the main ideas of the activity, participating in appropriate teaching/learning processes, and making personal connections. One can also identify places where users repeatedly express frustration, dissatisfaction, and/or misconceptions to other users. **Intellectual interactions** are those things that users do that demonstrate their engagement both with their minds as well as their hands. They can include things like expressions (both verbal and non-verbal), asking thoughtful questions, and repeatedly engaging in a particular activity until they "get it" (Perry, 1989, 1993).

All of the students whom we observed playing the games appeared to be **intellectually engaged** by the activities, as they first tried to figure out how to play the games and then worked to master them. It was interesting to watch some groups explore the limits of the games by purposefully trying to lose, setting up situations where Squish or the fish they had designed would be eaten. Respondents playing *Mysteries of Apo Island* were observed pausing to think about a clue and taking notes that indicated they were making comparisons, remembering facts, and matching facts with clues.

Through use of the mouse, students also seemed to be **physically engaged** by the activities. We often saw the actions that the students initiated on screen reflected in their own body movements. When two or more students shared a computer, they could sometimes be seen pointing at the monitor while discussing something. Those students who used the games in small groups often seemed to await their turn to use the mouse anxiously. In addition to evidence of positive physical engagement (e.g., leaning toward the screen and clicking experimentally with the mouse) exhibited by respondents playing *Mysteries of Apo Island*, a few respondents also yawned after using the interactive for approximately 50 minutes.

Students who played the games in groups were **socially engaged** with members of their groups, often in ways that contributed to their understanding of the games and the concepts they illustrated. One teacher related a story about the type of social interaction in her classroom:

The last time they used it [Build-a-Fish], some of them were getting frustrated. And others were saying, "Well, you know what? Get the blue—choose the blue color when you choose that [body]"...Actually, I can think of one little boy. He was getting really frustrated....But for him, that whole thing of using the arrows...wasn't responding fast enough. You know, it wasn't making those hairpin curves fast enough for when he was moving his fish around. That was really bothering him. And then, a girl who was across from him, she heard him getting—he goes, "I can't do this. I can't do this. It won't move. I tried to make it go down. It won't go down." And what was happening was...it wasn't doing it fast enough for him when he was doing the arrows. And she said, "Well, you know what? Don't use that body. Use this body and use this color, and then, you can get a lot." [052303-1]

Interactions were particularly intense when three students shared the computer, and angling to get the next turn was more important. We also saw lots of cooperative behavior, including taking turns and sharing, giving advice, discussing what to do next and why, and figuring out why their fish was eaten. Even students who we observed working at their own computers in the computer lab either worked without headphones or periodically took off their headphones to give hints or discuss their successes and failures with other students. Most of these students managed to make the computer lab a social experience, although a few played alone and didn't talk with others.

As mentioned before, two respondents who we observed playing *Mysteries of Apo Island* at home interacted with their younger siblings during the game. These interactions included sharing or disagreeing about possible answers, giving advice on and sharing frustration about technical aspects of the game, incorporating sibling comments into notes, and waving the sibling away from the computer.

It's important to note that ***Squish the Fish* and *Build-a-Fish* were fun enough that most students wanted to play them several times** over days, weeks, or even months. When teachers allowed their students to use the games several times, students retained physical, social, and intellectual engagement until they mastered both the games themselves and at least some of the concepts behind the games. During this study, we were unable to assess how respondents would engage with *Mysteries of Apo Island* after multiple exposures. We did see some indication that this interactive did not encourage repetitive play (see ***Less Successful Aspects of SEA for Students (and Their Teachers)***).

The degree of **social engagement** was also striking among the students we observed using the Explorer's Guide. Positive interactions included discussing what they read, subdividing the duties, helping poor readers in various ways, and working with other students to write the questions. A few groups argued about who was staying serious and on task, and who was not. There was very little loud talking and no disruptive behavior. This social engagement was the primary evidence for their **intellectual engagement** with the material, as they read

the text aloud, discussed it with their peers, and developed trivia questions. The task of taking notes and then converting these notes into trivia questions might be considered a kind of **physical engagement** shaped by their social engagement, one that reflected the quality of their intellectual engagement. The students' engagement lasted for most of the 60 minutes they sat at their computers.

Entry points

Based on his theory of multiple intelligences, Howard Gardner has described seven “entry points” that can help students become engaged with educational material: Narrative, Numerical, Logical, Existential/Foundational, Aesthetic, and Hands-on/Experiential (Gardner, 2000). Since most students we observed had played the games before, the issue of entry points was somewhat difficult. For the most part, students seemed to be wrapped up in the “Hands-on/Experiential” aspects of the games by the time we were able to observe them. In addition, this aspect of the investigation was hampered by the fact that we knew little about the relative strengths and weaknesses of each student with regard to Gardner's intelligences. Nonetheless, based on our observations, we are able to make a few comments about each of the entry points:

Narrative: This seemed to be part of the experience for both *Squish the Fish* and *Build-a-Fish*, although perhaps not as significant as it might have been under different circumstances. When younger students had to read the *Squish* text themselves, they often stumbled over or skipped much of the reading, and therefore much of the narrative thread was lost. That said, it seems that any game has a narrative thread to it—a narrative that users take an active role in—and this may have been part of the appeal of the game for many students.

Narrative seemed to be a strong entry point in *Mysteries of Apo Island* for some respondents. One said, “The introduction was cool. It made you think, ‘Oooh, this is really neat.’...it's kind of like *Gilligan's Island*.” [070303-1]

Numerical: Perhaps because the games didn't keep score, the numerical entry point didn't seem to be a major part of the experience for most students. However, we observed that some fifth grade students kept track of (and took pride in) how many times they “won” during their session at the computer.

Logical: Figuring out how to win the games seemed to be part of the appeal, and many of the students we talked with seemed to have developed rules for winning the games.

Mysteries of Apo Island, especially, required players to make logical deductions about the clues. Every respondent we observed made deductions, whether or not the deductions were correct. For example, one respondent typed the following solution after rearranging clues for the initial mystery in this order: tin can, legend, propeller, stingray:

Name of species: “*stingray*”

Description of species: “Everything gives off electromagnetic waves. The boat in the legend was giving them off so the shark attacked it. The ray was on the propeller and the shark sensed it, so it attacked. When the ray came off the propeller to defend

itself, the propeller took a chunk out of it. However the stingray continued to fight the hammerhead. In the end it died but it ended up killing the shark.” (070303-2)

Existential/Foundational: As we talked with students during our observations, we were able to elicit descriptions of some of the principles underlying the games, including “blending in” (or camouflage) for *Squish the Fish* and adaptations for *Build-a-Fish*. Some teachers also described follow-up discussions of the games that seemed to move students towards a better understanding of the underlying ecological principles of the games, since most students didn’t seem to be going there on their own. In other words, Existential/Foundational issues seemed to be an outcome reached through adult guidance rather than an entry point.

Aesthetic: The colorful, cartoon-like nature of the artwork in *Squish the Fish* and *Build-a-Fish* seemed to appeal to many students and may have helped pull them into the experience. Photos and images created interest for players of *Mysteries of Apo Island*.

Hands-on/Experiential: This seemed like the most obvious “entry point” for most students we observed using the interactives. While they may have briefly listened to the narrative, students tended to dive into game play as soon as possible. One student said about *Mysteries of Apo Island*:

I think it is nice ‘cause it teaches you, but there’s something you gotta do other than just learn about the animal. It’s not like some things where you just kind of read about the animal... You’ll remember the things more because you have to remember them and think about them to figure the project out. (070203-1)

Interpersonal: All the classes we observed engaged in social behaviors as they played the games, even when students sat at individual computers. They helped each other get started and overcome obstacles, bragged about their conquests, devised strategies, and shared advice about how to win. According to the teachers, some students really enjoyed giving advice and did so more often than others; for them, exercising interpersonal skills seemed to become part of the appeal of the games. Based on our limited sample of middle school students at home (rather than in a classroom), we saw a few indications that *Mysteries of Apo Island* may encourage interpersonal interactions, such as sharing ideas about which clues belong together and how to play the game.

An Eighth Entry Point: We were able to observe a second grader known to be particularly strong on Gardner’s eighth intelligence—the naturalistic intelligence (Gardner, 1980). One subject he had applied his naturalistic abilities to, over the last few years, had been fish. When this respondent started playing *Build-a-Fish*, he actually looked at and read the descriptions of the real animals. (This contrasted markedly with what we had seen during our formative evaluation of the game, when many students paid little attention to the descriptions of the representative species.) For this respondent, the entry point to *Build-a-Fish* might be described as either an interest in the subject matter, or, adapting Gardner’s language, the Naturalistic entry point. After the first five minutes, though, the second grader seemed caught up in trying to “win” the game, like most of the other children we observed.

The entry points approach to student engagement seemed somewhat useful in understanding our observations. It probably would have been more useful if we had:

- Observed more students as they played the games for the first time.
- Had some prior knowledge of each respondent's strengths and weaknesses relative to the eight intelligences.

Intrinsically motivating experiences

To understand the appeal of game playing, it helps to use a third way of thinking about engagement, which can be called “intrinsically motivating experiences” or, less formally, “What makes learning fun?” This approach was originally based on computer games. The components of this model were first described by Thomas Malone and Mark Lepper (Malone, 1980, 1981; Malone & Lepper, 1987) and later developed for museum settings by Deborah Perry (1989, 1992, 1993a, 1993b). Perry's version of the model of intrinsically motivating experiences identifies six important components that help motivate learning by making it fun, satisfying, and successful for users. The following section lists the components and describes how they relate to the *SEA* games.

- **Curiosity:** *Surprise and intrigue the user.* Curiosity was most obviously a part of the first few attempts to play the games, as students explored the world of the game and were continually surprised as events unfolded. Of course, some of the surprises resulted in disappointments, as fish were eaten or starved to death. However, all students we saw seemed to take these in stride and continued playing, as one boy explained, “One time the predator fish was the same fish as mine. Then I got stuck at the top, so I built a new fish.” (052803-1)
- **Control:** *Help users feel “in charge.”* Part of the appeal of the games was the ability to influence and control events on the screen. This is why users in groups often competed for control of the mouse and, when lacking control, freely gave advice.

Respondents playing *Mysteries of Apo Island* appeared to feel less in control of the game than those playing the other two interactives. All respondents said they sometimes were confused about what to do, especially at the advanced level. They dealt with their confusion in different ways ranging from patiently trying multiple guesses to exclaiming “No! Quit coming up!” in response to “Are you done matching?” appearing repeatedly on the screen. (070303-2)

- **Challenge:** *Encourage users to do or learn something new.* In most cases, the level of challenge was appropriate, although first-time users and younger students often felt overly challenged as they lost the first few rounds. With time, practice, and help from other students, most users found that they were up to the challenge—although they were able to describe their initial frustrations even weeks after mastering the games.

Some students using *Mysteries of Apo Island* had too much difficulty during the advanced level of the game. In one case, a player let his younger sibling play the game after becoming frustrated with it. Difficulties seemed to arise partly because the directions for the object of the game were not clear. For example, one respondent didn't know that he “should” be looking for four animals instead of one. Of course, this

finding might be different if the interactive were used in a classroom setting and a teacher or peers were available to help students figure out how to play the game.

- **Confidence:** *Help users feel safe and smart.* Once players had begun to figure out how to keep their fish alive, they gained confidence in their abilities. For *Build-a-Fish*, users often expressed this confidence by trying new and more challenging combinations of mouth, body, and coloration.

Mysteries of Apo Island challenged respondents' confidence at times and in some cases made them less interested in playing the game. For example, one respondent submitted two correct and two incorrect solutions to Dr. Fisher. The student said that he would have liked her to say he was close or that two were correct so he could focus on solving the remaining mysteries.

- **Play:** *Encourage playfulness and sensory exploration.* Both *Squish the Fish* and *Build-a-Fish* inspired playful behavior although, in part because of the ages of the users and the relative difficulties of the games, *Squish the Fish* seemed to be more playful than *Build-a-Fish*. The visual design of *Squish*, as well as his voice, seemed to heighten this interactive's playfulness. In contrast, *Mysteries of Apo Island* was less playful and required more concentration from respondents.
- **Communication:** *Stimulate meaningful conversations.* As stated several times earlier in this report, social interactions played a large role in the experience of *Squish the Fish* and *Build-a-Fish*. While our limited study of *Mysteries of Apo Island* showed evidence that it stimulated some conversations, further classroom observations would be necessary to fully understand to what extent the interactive meets this component.

One strength of the *Build-a-Fish* and *Squish the Fish* interactives seems to be that for most of the time, most users successfully fulfilled all six components of the model of intrinsically motivating experiences. On the other hand, *Mysteries of Apo Island* fulfilled fewer components of intrinsically motivating experiences, suggesting that it is probably more appropriate when used by a teacher as a supplement to a structured curriculum.

Contributions to Student Learning and Performance

Squish the Fish and Build-a-Fish

With *Squish the Fish*, students seemed to both recall and rehearse ideas they had learned before and sometimes to develop new ideas. They also learned the names and something about the behaviors of the animals, including some that were new to them (especially in Part One of the game). With *Build-a-Fish*, students seemed to learn about the complex interrelationships between physical adaptations and behavior, and were sometimes able to generalize what they had learned. What follows is a discussion of some specific aspects of student learning and performance.

- **Learning about the animals.** On one level, these games allowed students to gain a better understanding about the life habits and adaptations of certain species or types of

animals. By playing *Squish the Fish*, students seemed to learn more about the individual species. By playing *Build-a-Fish*, students learned about body, mouth, and color types (like “torpedo body” and “bottom-feeder”) rather than individual species. In fact, most students seemed to ignore the animal names on the “Choose Body/Mouth/Color” screens.

- **Learning more about familiar animals.** Many students were already familiar with some of the animals in *Squish the Fish*, including the Seastar (often called “starfish”), Seahorse, and Clown Fish in Part 1 and Seahorse and Octopus in Part 2. The students seemed to enjoy seeing these familiar animals in the game, and their familiarity seemed to help students understand why Squish was not eaten when he emulated them. Students starting out knowing only the names of the animals often seemed to learn new ideas about their camouflage or behavior.
- **Learning about unfamiliar animals.** Younger students seemed to be less familiar with certain animals in *Squish the Fish*, including the Goby, Urchin, and Clam in Part 1 and the Silversides and Sergeant Major in Part 2. These students sometimes learned the names of these animals and something about their behavior; they seemed to learn more if one of their group members was already familiar with the animal and could help read the name and explain their behavior.
- **Learning about the underlying concepts.** By the time they had finished playing the games, most students seemed to understand what the main points of the games were—“blending in” or “camouflage” for *Squish*, and adaptations in body/mouth shape and color/pattern for *Build-a-Fish*. One teacher explained what she thought her students learned from *Build-a-Fish*:

I think just a better appreciation of how animals are suited to a particular environment. That so much of what they look like, of what their body is—it’s necessary for them to be in a particular environment...That each animal fits into a certain habitat. (052303-1)

- **Learning how to “win” the game.** For most students, learning how to keep Squish (or the *Build-a-Fish* they had designed) alive was an important step in understanding the concepts behind the game. One teacher explained:

Some of them have figured it out. They have it down. They know exactly what combinations to get. And others of them still—it still hasn’t sunk in that if this animal eats coral, you’ve got to choose a body that’s going to work when you have it down in the coral reef, you know....They’re not realizing that all the parts of the body that they’ve learned...you know, in other classes that we’ve had and in other experiences they’ve had in the classroom and in other things they’ve read. They know that the whole body has to fit in with where it lives....some of them still don’t get that connection. When they go to play the game, they want to play the game....They don’t want to stop and think about “I have to make a good choice here about what body and what mouth and what color.” It’s just, “Oh, let’s just play this color to do it.” And then, they get frustrated when it doesn’t work out. (052303-1)

When we asked third grade students to articulate their understandings of the *Build-a-Fish* game in the form of advice to other plays, they came up with a range of answers. Some of the advice included simple hints:

If you pick a mouth that eats shrimp and crabs you will win.

If you pick shark teeth you can eat other fish.

If you keep on losing you will starve.

This simple advice did not reveal an understanding of the complex interplay of physical adaptations and behavior. However, most of the students in our sample gave advice that did reveal a better understanding of the complexities of the game, including the need to coordinate body, mouth, and color pattern. Here are some examples:

The rocket body makes it easy to swim. If you choose a rocket body, you should choose a mouth to eat other fish and a blue pattern to blend in with the water.

I would pick the bottom feeder mouth or the reef grazer mouth with the pancake body, and the color would be the polka dotted one or the blue one!

You want to read about the body, mouth, and face because it tells you what it eats and what can eat it.

However, even after several sessions with the game, some students apparently had not learned how to be successful, as suggested by the following advice.

A fish with spots eats a fish with stripes.

If you eat a small fish and you are a big fish you can eat it.

However, most students' written advice suggests that, after several sessions with the *Build-a-Fish* game, they had begun to master both the game itself and some the ecological concepts that were designed into the game. For a larger sample of the students' advice to other students, see **Appendix F**.

- o **Building on prior understandings of concepts.** Even the Kindergartners in our sample seemed to come to the *Squish the Fish* with a basic understanding of the idea of "blending in," and most the students who played *Build-a-Fish* seemed to have some understanding of adaptations before using the interactive. The teachers said that by playing the games, these students were able to play with the ideas in a hands-on way which furthered their understanding.
- o **Learning about unfamiliar concepts.** It appeared that many of the students who played the games had not thought much about the relationship between a fish's camouflage (and its other adaptations) and the way it behaves, including where it

- lived, what it ate, and how it avoided predators. Mastering these games included figuring out how to make the animal behave—including hiding Squish in Part Two and figuring out where to hunt in *Build-a-Fish*. It's important to note that there seemed to be a close correspondence between mastering the games and understanding the basic concept of the relationship between physical adaptation and behavior.
- o **Understanding specific applications of the concepts.** Success in playing the games often, but not always, involved mastering specific applications of the underlying concepts. In the Part One of *Squish the Fish*, players usually understood why Squish was protected when it hid with the seahorse, eel, or urchin, but sometimes they successfully hid Squish without understanding why it was protected. For instance, most students could name the Clown Fish but couldn't clearly explain why the anemone protected it. The first few times through *Build-a-Fish*, students often faced difficulties figuring out how to get their fish to “behave” in ways appropriate to its adaptations—swimming in the right place, and so forth. As they gained experience, students often paid more attention to the “Best Habitat/Best Food” hints screen, so they could start the game with their fish behaving in appropriate ways.
 - **Learning through repetitive exposure.** Some teachers emphasized that repetition was the key to developing their students' understanding of key concepts. They said that students had to be exposed to these ideas many times, and that some might not pick up the ideas until the second or third time. Whether the games were used to introduce, repeat, or reinforce major concepts, they still played an important role in the learning process, because they were a fun and intellectually engaging way to repeat students' exposure to important concepts.
 - **Generalizing SEA concepts to other settings.** Several teachers discussed evidence that their students were able to generalize concepts learned from the games to other settings. Teachers gave examples of students (1) extending what they had learned about adaptation in coral reefs to adaptations of animals living in polar and desert habitats, and (2) generalizing camouflage concepts from fish to other vertebrates.
 - **Testing students' existing understanding.** The teachers of the fifth graders said that although the *Squish the Fish* and *Build-a-Fish* seemed below the ability levels of most of their students, the games were an excellent way for students to test their own learning. They said that the games were very motivating for their students because the experiences reassured them that they understood the concepts included in the games.

A number of factors seemed to increase student learning from the games. Students seemed to learn more when:

- **The games were used several times on different days.** It is important to note that the games can maintain student interest through several sessions.
- **The games supplemented a structured curriculum** on similar subjects.
- **Teachers discussed the concepts** behind the games with students before, during, or after the game-playing sessions. According to one teacher, some students appeared more

interested in playing the game than learning. However, these students remembered enough of the game that during the discussion, they were able to learn “through the back door.”

In addition, several teachers stressed their belief that students learned more from the games because they were **interactive experiences**. They said that when students learn from interactive experiences, they tend to retain ideas longer and better than if they had simply done library research or heard the teacher talk about the ideas in class.

Mysteries of Apo Island

- **Learning about sharks.** All of our respondents—even ones that knew quite a bit about sharks beforehand—learned at least one new fact about sharks. They learned, for instance, that hammerheads sense things by electromagnetic pulses, that thresher sharks have long tails, and that a type of shark is called a cookie cutter.

Prior knowledge of sharks and aquatic life sometimes interfered with playing the game. For example, one respondent thought the thresher shark didn’t live in the Philippines so he mistakenly eliminated that possibility as an answer. The correction of these misconceptions could be viewed as a type of learning.

- **Learning about the underlying concepts.** Respondents unfamiliar with different sharks seemed to come away from the game learning something about shark biodiversity (they learned there are different types of sharks) and shark behavior (they learned distinct behaviors of different types of sharks). However, the conceptual learning didn’t appear to be as strong as the factual learning, since our respondents all reported their learning in the form of facts—not in the form of concepts.
- **Practicing skills.** The strongest contribution that we saw *Mysteries of Apo Island* make to student learning and performance was that of encouraging our respondents to practice and apply critical thinking skills. We saw all respondents using observation and reasoning skills while playing the game. For example, one respondent explained how she came up with the solution by comparing the images and matching clues with information from fact cards:

I think the smiley fish is a whale shark...because it says these teeth are less than three millimeters...and it filters fish...mainly tiny plankton and in one of the things there was a bunch of plankton around the fish and it looks a whole lot like that picture. (070203-1)

Respondents practiced note taking, organizing, and typing skills while playing *Mysteries of Apo Island*. Some respondents playing *Mysteries of Apo Island* disliked the time and effort involved in the note taking the interactive required. This skill, interestingly, is one that a middle-school librarian said she wanted to make sure her students practiced—even if they didn’t enjoy doing so.

Explorer's Guide

Based on our observations and discussions with the teachers, the fifth grade students who used the Explorer's Guide seemed to learn new facts about the animals. The students also developed questions, especially facts that the teachers referred to as odd bits of information that attracted their attention. In addition, these teachers said that the students:

- Encouraged their families to go to the aquarium.
- Visited the Web site at home.
- Thought about conservation of sea life, which motivated them to learn more.

Using the Explorer's Guide seemed to be mostly be "about" learning facts concerning specific animals (some of the animals were new to students), and this is what most students appeared to take away from the experience. There was also some practice in note taking, cooperative behavior, and writing, but students were proficient in these skills even before using the Explorer's Guide.

Students' Reactions to SEA

What Students Enjoyed Most about SEA Resources

Most students seemed to really enjoy the playing *Squish the Fish* and *Build-a-Fish*. They paid attention (even when it wasn't their turn), got involved with the creatures, and worked hard to win. Those who weren't playing tried their best to get a turn on the computer or to watch what was happening. Most students seemed to care about being successful in the game.

Respondents who played *Mysteries of Apo Island* also enjoyed their game, but did not seem to enjoy it as much as the *Squish the Fish* and *Build-a-Fish* players enjoyed their games. When asked about the interactive, all of our respondents tended to emphasize that it was educational, rather than describing it primarily as fun. For example, one respondent said:

One thing about this game...I mean, it's very detailed and very educational. But it's long and you have to type a lot. In school, people don't like typing a lot. They like games that are a little faster, unless they're like Myst [a computer adventure game] players and they play those kinds of games....It's good detail, a good idea, it's cool but it takes a while and some people would probably lose interest after awhile. (070303-2)

It's pretty fun but... it's not like a super fun game. It's something that helps you learn but I wouldn't recommend it that much as fun. It's pretty interesting, though. (070303-1)

This finding is not surprising, given that *Mysteries of Apo Island* is slower paced than the other two games and requires students to take notes and think carefully about solutions.

Two factors seemed to lead to varying degrees of enjoyment among the respondents who played *Mysteries of Apo Island*. One was their comfort with the game's level of challenge. The students enjoyed the game more when they were able to make steady progress through the game. For example, the student who solved all the mysteries within a couple of tries enjoyed the game the most. Another student who solved the initial mystery within two tries reacted positively to the first part of the game but negatively to the advanced level, when he had to

try a number of times before succeeding. The third student was unable to solve even the initial mystery and lost interest in the game. A student's personality type also affected enjoyment of the game. For example, one student who seemed, by nature, more patient and interested in details enjoyed the game more than those who disliked note taking.

Still, there were some elements of *Mystery of Apo Island* that all the respondents enjoyed. The idea of solving a mystery intrigued them. They all appreciated the hints given by the fact cards which led to some "aha" moments and gave them renewed energy to try again to solve the mysteries. The images of shark exotica also captured the respondents' attention. They liked looking at them and often seemed to notice details based on close observation.

The fifth graders seemed to enjoy working with the Explorer's Guide, and commented on how interesting they found certain bits of information. Most retained interest and effort for the entire hour. Their enjoyment and attention seemed to be dependent on three factors: (1) The information sheets themselves; (2) the students' existing interest and knowledge about sea life; and (3) the trivia-question activity their teachers had developed in relation to the information sheets.

Less Successful Aspects of SEA for Students (and Their Teachers)

We noted some problems related to the students' experiences with *Squish the Fish*, *Build-a-Fish*, *Mysteries of Apo Island*, and the Explorer's Guide:

Interactives in general. The following two issues applied to *Squish the Fish* and *Build-a-Fish*:

- **Switching games.** When students played the games on-line, they sometimes had trouble moving from one game to another through the *SEA* teacher pages. More generally, when students used the pages aimed at teachers, they were exposed to a good deal of complexity and information that was not helpful. One teacher told us about the problems her students experienced:

But in giving my kids the direction, or our kids the direction last week, "you go to the SEA adventure," which is clearly on the upper left hand side of the page. They then had to go—once they got there, it didn't seem clear as to how to get into Squish the Fish or wherever they were going. And then, once they were there, the navigation out of it to the next one, Build-a-Fish, was a little obdurate. Our kids are savvy, so they...scroll on down to the bottom of the page and see if you could find your way back to interactives. But it might have been more helpful at that... link, to say "Other Interactives". (053003-1)

- **Issues related to screen area/size.** Screen resolutions on the computers used by students we observed varied from as low as 640x480 to 1152x870. The older Macs were usually set at 640x480 (small screen area) and the newer ones at 1152x870 (large screen area). Depending on the screen area, the area occupied by the games was either too large for the screen (so that students missed parts of the game screen) or smaller than the screen area (so that other windows were visible behind the game). When the game area was smaller than the screen area, students sometimes "lost" the game behind another window which they may have clicked accidentally. More accomplished computer users

could often relocate the game, but less accomplished users needed help. We also saw this problem twice with students playing *Mysteries of Apo Island*

Squish the Fish

In general, most Kindergartners needed help to get through the game the first time or two. The strategy of matching older and younger students seemed beneficial to the Kindergartners in our sample, and the game was so much fun that students persisted despite their initial frustrations. Specific issue included:

- **Part Two.** The teachers noted that some students experienced frustration with the second part of *Squish*; they couldn't get Squish back home. They seemed to be experiencing a number of difficulties first identified during the formative evaluation (e.g., figuring out that they had to move Squish to hide him, matching Squish's color to an appropriate background, etc.). However, these problems seemed much less severe than in earlier versions of the game, and, with practice and help from peers, most students figured out what to do by the second or third time through the game.
- **Reading difficulties.** When the sound was off, less able readers often stumbled over the text, and sometimes skipped large sections in order to keep the game moving quickly. Because of this, these readers tended to lose the narrative thread.

Build-a-Fish

Some students couldn't get the fish they designed to eat enough food to survive. For most students, these problems were experienced the first few times through the interactive. Once some students figured out successful strategies, they often taught their classmates how to succeed. More specific *Build-a-Fish* issues included:

- **Complexity.** The complexity of the game made it hard to win, at least at first. Students had to coordinate many actions and behaviors, and it took time to learn to do that.
- **Arrow keys.** Some students had trouble coordinating the three arrow keys with the stop key (Enter).
- **Biting.** The students could not figure out why the fish didn't always bite when they pushed the space bar.
- **Speed.** Some fish moved so slowly that they frustrated the students. Certain combinations of bodies and mouths caused more frustration (e.g., a slow body with a biting mouth). Students were seen tolerating the slow bodies in certain circumstances, such as in combination with the bottom-feeder mouth, once they figured out how easy it was to eat crabs and such. Perhaps their frustration was part of the learning process, but it was still difficult for some students.

The first and second issues improved with time for practice, but the other two did not.

Mysteries of Apo Island

- **Understanding the object of the game.** At various points in the game, our respondents had trouble understanding what they were supposed to be doing. During the initial mystery, most of our respondents didn't know what to type in the name of the species box. In one case, the respondent left the species name blank when taking the clues to Dr. Fisher. When Dr. Fisher congratulated her on figuring out the mystery, she then learned the name of the species. This respondent said:

I think there was some stuff that was a bit confusing for what you have to do. Like the instruction...I wasn't sure for putting the things together... I wasn't exactly positive. At first I didn't understand like what to type in that box at the top but then I figured it out. So I think the instructions could be a bit better. (070203-1)

Another respondent never figured out that all the answers would be about sharks. This finding suggests that, unlike *Squish the Fish* and *Build-a-Fish*, *Mysteries of Apo Island* as currently configured requires the context of a school lesson about sharks in order for students to play it successfully.

- **Difficulties using game elements.** Our respondents had difficulty using some of the game elements, such as opening, closing, and moving around solutions pages, as well as getting clues and fact cards to snap in place. The notebook screen in the advanced level sometimes caused problems because the screen was cluttered with clues and solution pages that were difficult to move around. Clues and fact cards sometimes jumped around the screen as students tried to manipulate them. In one case, the thresher shark fact card disappeared from view and the game could not be completed.
- **Dr. Fisher's lack of responsiveness.** During the game, the players we observed took actions which did not lead to helpful responses from the Dr. Fisher character. For example, students typed in species names from the fact cards or changed the order of the clues, expecting that this would lead to success with Dr. Fisher. All our respondents expected her to be more responsive to their particular situation and give them more hints:

She [Dr. Fisher] could...say, "You're close." Like, there should be a point in the game where you have the clues really close and it says you're so... instead of going, "Oh no, you're not, you still need some more work." (070303-1)

Similarly, one teacher who we had asked to look at the game pointed out that Dr. Fisher would be more helpful if she gave different hints instead of always saying "go back to the clues."

While it may be difficult from a technical design standpoint to make the Dr. Fisher character more responsive, the lack of more tailored responses was a point of frustration. Increasing this character's interactivity so that the game can respond to the players' particular situations is an enhancement that should be considered for future versions of the interactive.

- **Little incentive for repetitive play.** The *Mysteries of Apo Island* was a different type of interactive than *Squish the Fish* and *Build-a-Fish*. Unlike the other two, *Mysteries of Apo Island* appeared to be more limited, i.e., it would not be played repeatedly. Asked if they would play the game again, the students we observed responded in the negative, noting that they already knew the answers to the mysteries. For example, one respondent said he would probably not play it again:

It's kind of the same thing...because they'd have the same sharks pretty much each time. If they put in more, like a great white [it] could be really fascinating. (070303-1)

This finding does not necessarily indicate that *Mysteries of Apo Island* should be changed to encourage repetitive play. We do suggest, however, that when additional interactives are developed for the middle school level, it would be worthwhile to include some that lend themselves more strongly to repetitive play. In this way, teachers would have multiple types of *SEA* activities from which to choose.

Explorer's Guide

Many of the issues with these resources revolved around the students' reading of the text. The Explorer's Guide fact sheets were developed for a sixth grade or older audience. We found, however, that younger students were able to use them successfully. Although the teachers told us the reading levels of their students varied from second grade on up, most students seemed to read the text on the screen. All the groups we observed located the glossary (accessed by clicking words turned into underlined/contrasting-colored links), which aided comprehension of the text. However, users experienced a number of difficulties with the text:

- **Pronunciation.** A few students stumbled over longer and/or harder words. A few students requested that Shedd include pronunciations of the harder words in the glossary.
- **Reading hyperlinks.** In once or two cases, mis-readings of words seemed to be linked to the underlining of a word (e.g., "phytoplankton" pronounced as "photoplankton").
- **Issues related to screen area/size.** The browsers used by the fifth graders were Internet Explorer for Mac. Screen resolutions on the computers varied from 640x480 to 1152x870. The older Macs were usually set at 640x480 (small screen area) and the newer ones at 1152x870 (large screen area). We noted that the size of the monitor screen was not correspondingly greater for the differences larger screen areas, so that students with old computers with small screen areas had scroll a good deal in order to view the entire Web page. A few students knew how to reset the screen area, although they didn't necessarily re-size their windows to fit the screen. Two specific problems emerged related to screen size:
 - **Missed text.** Groups of students using monitors with small screen areas usually read the introductory paragraph about each creature (in bold italics at the top of the page), but then had to scroll right and down in order to see the photographs. Groups with

- large screen areas saw the photos right away and often clicked them, but usually failed to read the intro paragraph (starting instead on the paragraph about the animal's appearance).
- o **Small text.** In general, most students seemed to read fluently even when their monitors had a large screen area and correspondingly smaller letters, although they often had to lean forward to read the smaller type. Adults and poor readers seemed to have more problems with these settings.
 - **Issues related to the use of color in the on-line version of the Explorer's Guide.** The on-line version of the Guide used white text on a dark blue background, varying the shades of blue as part of the design. This resulted in two difficulties, mainly for older users and less able readers:
 - o **White text on dark screen.** Research suggests that white text on a dark background is harder to read than dark on white. In this case, teachers and a few students with below-level reading skills seemed to have the most trouble reading the on-line text off the monitors. The older folks specifically complained about the white-on-blue letters, but the students were less articulate about the source of their difficulties.
 - o **Chunking text.** The site used color (light vs. darker blue) to help break the text into chunks. For some reason, this showed up clearly on newer computers, but was less obvious on the older ones.

CONCLUSIONS

The *SEA* resource modules we assessed (i.e., the interactives and the Explorer's Guide) provided teachers with useful and useable supplemental materials for their aquatic science curricula. The teachers we observed and talked to who used the modules in their classrooms were able to adapt and integrate the resources into their curricula. The few teachers we talked to who had not used *SEA* in their classrooms believed that they would be useful resources and looked forward to using them.

This study also found evidence that the resources contributed to student learning. We saw and heard about students learning about animals, learning about underlying concepts, learning through repetitive exposure, generalizing *SEA* concepts to other settings, and testing their existing understandings.

Finally, in our interviews, teachers said that they needed and wanted more interactive resources as good as the ones provided by *SEA*.

Factors that contributed to a successful experience with *SEA*

We found that the following factors helped teachers and students have a good experience using the *SEA* resources:

- Teachers could pick and choose modules of *SEA* to use in their classrooms in the manner that they felt best suited their students. In some cases teachers chose an interactive as a supplement to a lesson, while in others they adapted the Explorer's Guide itself into a classroom activity. Teachers could successfully use these resources in their classrooms without adopting an entire lesson plan. From our front-end evaluation, we know that teachers don't take entire lesson plans from other sources, so a resource that doesn't expect or force teachers to do this would be more useful to them.
- The concepts covered by the *SEA* resources were general enough that teachers could integrate the resources with their varied curricula. For example, some teachers used the resources to teach about ocean life, while others used them to supplement units on vertebrates or animals in general.
- *Squish the Fish* and *Build-a-Fish* interactives did not demand extensive preparation or support from teachers for students to use them. For the most part, students could play the games without much assistance from teachers.
- *Squish the Fish* and *Build-a-Fish* interactives were fun, which encouraged students to play them multiple times, thus increasing their exposure to new concepts and further reinforcing their learning. Moreover, teachers enjoyed seeing their students engaged by resources related to what they were trying to teach.

- The interactives engaged students on multiple levels, including intellectually, physically, and socially.
- Most of the time, for most users, the *Squish the Fish* and *Build-a-Fish* interactives successfully fulfilled all six components that help motivate learning by making it fun, satisfying, and successful for users.
- The *Squish the Fish* and *Build-a-Fish* interactives presented an appropriate challenge for most students in the suggested grade levels. (*Mysteries of Apo Island* was too challenging for some students we observed, but may be less challenging if used as a lesson supplement. It might also present a more appropriate level of challenge if Dr. Fisher provides more tailored assistance, the instructions are clearer, and the game elements are easier to manipulate.)
- The mystery format of *Mysteries of Apo Island* caught students' attention, engaging them intellectually and serving as the intended logical entry point. It encouraged them to apply observation and reasoning skills. Students tried diligently to solve the mysteries by taking notes and comparing and interpreting clues and fact cards.

Factors that detracted from a successful experience with *SEA*

We identified five factors that detracted from the overall good experience respondents had with *SEA*:

- For both teachers and students, technical difficulties detracted from the overall experience. People without Flash installed on their computers ran into difficulty when trying to use the interactives and were unable to access technical help easily. Users were not warned how slow the interactive downloads would be when using a dial-up modem for on-line access. We also found respondents struggling with screen sizes.
- *Mysteries of Apo Island* was difficult for some respondents to play successfully as a standalone activity at home because of unclear instructions, difficulties manipulating game elements, and the limited responses of Dr. Fisher. These problems led to frustration, took up time and energy, and detracted from learning.
- Teachers and students found missing files or poorly edited text in lesson plans and the Explorer's Guide that, though the errors were minor, negatively impacted their view of *SEA* resources.
- Teacher perceptions of *SEA* were also negatively affected when they found resources labeled as appropriate for their grade, but which they perceived as too easy or difficult. As mentioned above, however, the *SEA* lesson plans were pulled directly from activity guides that had been previously tested for age-appropriateness with a larger pool of teachers than this current study.

- The on-screen text caused some problems for teachers and students. Small text and reverse text in the on-line version of the Explorer's Guide was difficult for some people, especially older respondents and less able readers. The color differences used to chunk text so that it was easier to read were too subtle on older computers.

RECOMMENDATIONS

This summary of suggestions for improving the *SEA* resources is based on the results of our evaluation. Some of these recommendations are related to future enhancements to the site; some are simply things to keep in mind when developing other on-line projects.

Evaluations with Teachers

Although our data suggest that many teachers incorporate new materials into their lesson plans year-round, it was difficult to recruit teachers who could use specific components within the context of a planned instructional unit on short notice, especially at the end of the school year. Therefore, we recommend that future evaluations:

- Begin earlier in the year (no later than January, preferably earlier).
- Include a longer interval of data collection (three months or more).

This earlier, and longer, time frame would make it easier to evaluate the materials within a natural context.

Teacher Use of the CD-ROM

- **Technical help.** Place technical help directly on the disk, rather than including a separate printed sheet with the needed information.

Text

- **Text errors.** Ensure that all typographical errors and other inaccuracies are corrected in the lesson plans and Explorer's Guide.

Web Page and Interactive Design

Most of these recommendations should be considered in future Web designs, although the first recommendation also applies to the current *SEA* Web site.

- **Readability.** Consider making changes to the current text/design in order to improve readability. Suggested changes might include removing italics from the first paragraph in the Explorer's Guide pages.
- **Text/Background colors.** Since Shedd's Web site users include many older people and beginning readers, future iterations of Shedd's overall Web site design should allow for use of dark text on light backgrounds.
- **Color as a design tool.** Be careful using designs based on relatively subtle color differences (like shades of blue), because such designs will be less effective on some monitors.

- **Screen size.** Be careful of designs that de-emphasize certain items depending on the screen area/resolution (e.g., the first paragraph in the Explorer's Guide sheets).
- **Usability.** Make sure, using explicit instructions and good visual design, that the object of the interactive is easy to understand and that game elements are intuitive to use. Successful examples of instructions include those on how to take photos and notes in *Mysteries of Apo Island*. Consider providing demonstration/practice screens that show how to manipulate game elements.

Student Use of the *SEA* Web Site

- **Student home page.** Consider developing a home page, aimed directly at students, that could provide direct access to the interactives and Explorer's Guide sheets but not include information aimed at teachers.

Other Modifications and Additions to the Current *SEA*

- **Screen size.** Include a recommended screen size on the introductory page for each game.
- **Technical help.** Include a more specific text link to technical help on the introductory page for each game—something like “If you can't get the interactives to play, go here for help.”
- **Download times.** There is currently no indication on the interactive pages that warns about slow download times for users who access the games on-line with a dial-up modem.
- ***Mysteries of Apo Island.*** Increase the interactivity of the Dr. Fisher character so that her response to students' solutions is more tailored. In addition, to the extent possible at this stage of development, clarify instructions about the object of the game at both the initial and advanced levels, and make it easier to control game elements (e.g., use visual design to indicate where to place fact cards on the solutions page and where the cursor must be placed in order to move the solution pages around, and design the game to accept placement of objects or the cursor within a larger area so that students don't need to be so precise in their actions). This recommendation involves considerable programming changes which would require additional funding.
- **Off-line resources.** Add links to Shedd's off-line resources to the lesson plans and interactives intro pages, such as links to information about related Discovery Boxes, aquarium exhibits, and tours.
- **Answers for teachers.** Include answer keys for the printable student worksheets.

Additional Lesson Plans

Below are two recommendations to consider when adding lesson plans to either the current version of *SEA* or to future versions:

- **Determining grade ranges.** Because the proper assignment of grade levels seems to be a very important issue with teachers, continue to use a group of teachers like those who reviewed the original activity guides to review closely all lesson plans—including their recommended grade levels—before posting them on the Web.
- **Appropriate range of grade ranges.** To maximize the possibility that teachers will be directed to resources appropriate for the ability levels of their classes, Shedd should add lesson plans and ensure that each grade falls within the lower, middle, and upper parts of the suggested age ranges for one or more plans. (In other words, if fifth grade teachers search by grade level, they might find plans suggested for grades 3-5, 4-6, and 5-7.)

Future Additions to *SEA*

Based on teachers' and students' suggestions, Shedd should seek funding for adding the following resources to *SEA*:

- **Resources related to other ecosystems and topics.** These could include lesson plans, interactives, and information sheets developed for other aquatic habitats and/or ecosystems (e.g., Illinois rivers, the Amazon, and the deep sea), ocean exploration, and ocean/freshwater conservation.
- **Pre-visit materials for teachers and students.** These could include a range of materials to help prepare for a tour of Shedd's exhibits, including maps of the building and other materials they could easily modify as they plan their own trip and make their own worksheets.
- **Other forms of interactivity.** These could include (1) Web Quests and (2) on-line quizzes or other interactive features to help students test and reflect on their own.
- **Explorer's Guide for beginning and early readers.** These should include similar information to the existing sheets, but use less and simpler text and more graphics. Perhaps developers could start with sheets that give more detailed information about the animals in *Squish the Fish*.
- **Search feature that also returns remedial and advanced activity suggestions.** This feature would help teachers who teach a range of students below, at, and/or above their grade level, but who may not have the time to search three different grade ranges.
- **Additional Spanish language features.** These should include not only Spanish language versions of elementary school level interactives, but also Spanish versions of middle school and high school interactives so that students at all levels of English proficiency can learn about aquatic science.

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APPENDIX A: TOPICAL FRAMEWORK

Shedd Educational Adventures/On-line Teacher Resources
Summative Evaluation
Topical Framework
John G. Shedd Aquarium

Submitted by Selinda Research Associates, Inc.
May 15, 2003

Teacher Experience

General

- What are some of the ways that teachers found and chose the various types of *SEA* resources (e.g., lesson plans, interactives, etc.)?
- What are some of the ways that the teachers we talked with used *SEA* resources (e.g., searching for concepts, searching for themes, planning entire lessons, filling in existing lessons, etc.)?
- What is the range of resources used by teachers, both as individuals and as a group?
- What are some of the ways that teachers integrate *SEA* resources into their curriculum?
- What are some ways that teachers are adapting *SEA* resources for their classrooms? In what ways do they supplement *SEA* resources with activities from other Web sites?
- In what ways did teachers have to prepare to use the *SEA* resources in their classrooms?
- What are some situations in which teachers intervened or assisted their students when using the student activities?
- What are some factors that seemed to contribute to successful use of a *SEA* lesson plan? What, if anything, might be missing from the lesson plans? What other lesson plans would be useful to teachers?
- What are some factors that seemed to contribute to successful use of a *SEA* activity? What, if anything, might be missing from the activities?

Professional Development

- What are some ways in which *SEA* contributed to teachers' knowledge, skills, and/or approaches to learning and teaching? Did *SEA* contribute to a teacher's ability to integrate concepts into their classroom? Did it help a teacher see how aquatic science topics can relate to specific standards? Did it spark different ideas for using *SEA* in the future?

Technical

- In what ways did the teachers use the technology components of the *SEA* site (e.g., did they download lessons, print worksheets, etc.)?
- In what ways did the technology components help or hinder the use of the resources?
- How did *SEA*'s affiliation with Shedd affect teachers' perceptions of the site? In what ways did *SEA* affect the use of other Web sites by the teachers?

Enjoyment

- What value, if any, did teachers see in *SEA* resources for themselves?
- What did teachers enjoy most about the *SEA* resources? What aspects seemed less enjoyable and why?

Student Experience

Learning

- What are some of the ways that these teachers' students used the *SEA* resources/activities?
- In what ways did students engage and interact with the interactive modules?
- What contributions did *SEA* seem to make to student learning and performance?
- What value did the teachers see in *SEA* lesson plans and activities for the students?
- In what ways did teachers believe *SEA* contributed to students' learning?

Enjoyment

- What did students seem to enjoy most about the *SEA* resources? What aspects seemed less enjoyable, and why?

Online Survey

- How did the respondents become aware of the *SEA* resources?
- How did the technology components help or hinder the use of the resources?
- How did the respondents use the technical help? To what extent was it helpful to those who used it?
- What components available on the *SEA* site (fact sheets, worksheets, etc.) did the respondents refer to? How useful was the related information? What did they request that is not already on the site? Did they request things that are already on the site because they were unable to find them?
- What other sites for science and education did respondents frequent? What did the respondents coming to the *SEA* site look like demographically (e.g., the grades they teach, the subjects they teach, the states in which they live, urban/suburban, etc.)?

APPENDIX B: INFORMATION ABOUT RESPONDENTS

Classes observed:

Grade	Type of School	Location	Number of students
K/1	Public	Chicago	9
2/3	Public	Chicago	8
3	Public	Suburban Chicago	14
3/8	Public	Suburban Chicago	22/21
5	Public	Suburban Chicago	33

Teachers interviewed:

Grade	Type of School	Location	Subject
K/1	Public	Chicago	General ed.
2/3	Public	Chicago	General ed.
3	Public	Suburban Chicago	General ed.
3	Public	Suburban Chicago	General ed.
3	Public	Suburban Chicago	General ed.
5	Public	Suburban Chicago	General ed.
5	Public	Suburban Chicago	General ed.
7/8	Public	Suburban Chicago	Biology, Chemistry
9-12	Public	Springfield	Biology, Chemistry
9-12	Public	Springfield	Biology

Additional students observed or interviewed:

Grade	Type of School	Location
2	Public	Suburban Chicago
3	Public	Suburban Chicago
7	Public	Suburban Chicago
7	Private	Suburban Chicago
8	Public	Suburban Chicago

APPENDIX C: SAMPLE PROTOCOL FOR IN-DEPTH INVESTIGATIONS

Shedd Educational Adventures/On-line Teacher Resources Summative Evaluation John G. Shedd Aquarium

Pre-Observation Protocol May 15, 2003

- Introduce yourself (what you're doing, why it's important to talk to them, etc.; explain that you're an independent consultant).
- Note that the interview will take about 20 minutes.
- Explain the process (no right or wrong answers, confidentiality). Get their permission to tape record. Ask if they have any questions before getting started.

Introduction

1. Thanks for allowing us to observe your classroom on <insert day of observation>. Could you briefly describe how are you planning to use *SEA* resources with your class during our observation?

General

2. Please tell us how you will be using *SEA* resources with your class. Which resources will you use? How did you choose those particular resources you'll be using? In what ways does this fit your plan of study for this unit? (e.g., does it fill in an existing lesson? Is it a new lesson that relates to a concept or theme? etc.)
3. How do the resources you chose support your school or district curriculum? In what ways do they support state standards?
4. How did you find the *SEA* resources you will be using in your lesson (i.e., From contact with Shedd? Through another teacher/word-of-mouth? Your principal/media specialist distributing the info? etc.)? Did you go to the *SEA* Web site or use the CD?
If they used the Web site: How easy was it to find what you needed on the Web site? What were your overall impressions of the site (i.e., is it a trustworthy source of information)?
5. In what ways did you supplement the *SEA* resources with material from other sources? If so, what are the supplemental materials, and where are they from?
6. In what ways did you have to prepare in order to use these resources in your classroom? (e.g., did you have to walk through the lesson? Use the interactive yourself? Do more research on a topic? etc.)
7. *If they plan to use a lesson plan:* Was there anything you needed that the on-line lesson did not mention or provide?
8. *If they are planning to use an activity:* Did you find anything missing from the activity that would have helped you prepare to use it?

Technical

9. Thinking back to when you were on the Web site or using the CD, what kinds of things did you do on the site? Did you search for key words? Copy text to Word? Download lessons? Print worksheets? Did you have any problems doing these things?

Students

10. What do you expect your students to take away from the lesson you'll be teaching? What aspects do you expect to be easy for them? What aspects do you expect to be more challenging for them?

Logistics for observation

Let's briefly talk about the observation.

- I will be at <insert school name> at X o'clock.
- Is there a certain place I should park?
- I'll check in at the office and have them call you.
- All I need in your classroom is a chair someplace that will not interfere with your lesson.
- If it's OK with you, I'd like to walk around and talk to kids when it is appropriate during the class—for example, while they are performing the activity.

Closing

11. Thanks for allowing me observe your classroom. Do you have any questions for me?

Classroom Observation Protocol May 15, 2003

- Get settled in; find a space with a good view.
- The following guidelines will help with the observations and debriefs.

Lesson

1. Describe the context (what concept/theme does lesson and/or activity relate to, notes about the room set up, how many students, time of day, where participants are placed, etc.).
2. Describe the lesson and the use of the *SEA* resources within the lesson. If they are having the students use the on-line interactives, describe how they introduce, support, and wrap-up/summarize the experience.

Teacher Experience

3. How do the *SEA* resources seem to fit into the lesson the teacher is teaching? [Note: you are not *rating* the teacher, just whether this seems like an appropriate way of integrating the resources into lessons. You could think of rating this high/medium/low based on how well it fits in.]
4. In what ways, if any, does the teacher change the plan she or he previous told you about when actually using the resources? (e.g., did the web connection fail, so the teacher had to substitute a worksheet? Did part of the lesson plan have to be skipped because it took too long? etc.)
5. How does the teacher adapt the *SEA* resources during the class? How does the teacher supplement the *SEA* resources?
6. Does the teacher intervene or assist his or her students when using the student activities? In what instances did this happen?
7. Does the lesson or activity seem successful? What factors seem to contribute to its success? What factors seem to detract from its success?

Student Experience

"Intercept" questions for the students might include:

- What are you doing?
- Can you explain <concept> to me?
- What do you think this is trying to tell you?

8. In what ways are the students using the *SEA* resources?
9. How are the students responding to the *SEA* resources (their level of enthusiasm, attention, and effort, smiling, etc.)?

In the case of interactive modules: What entry points as described by Howard Gardner do students seem to be engaging with (Narrative, Numerical, Logical, Existential/Foundational, Aesthetic, Hands-on/Experiential)?

10. What kinds of interactions do participants have with each other while using the resources? How would we characterize these interactions?
11. What contributions do the *SEA* resources seem to be making to student learning and performance?
12. Is there evidence that students are connecting with what they are doing? [e.g., do they seem interested and personally involved?]
13. What evidence is there that students seem to be enjoying themselves?

Overall

14. What is the nature of the teacher experience?
15. What is the nature of the student experience?
16. In what ways and to what extent does the use of *SEA* resources appear to be effective for the participants?
17. In what ways are they less effective?

Final things to think about:

18. What really stood out or impressed you?
19. What are some of your concerns?
20. What would you tell the client at this point about *SEA*?
21. Based on your data collection to date, what seem to be the important components in making *SEA* successful?

Post-Observation Protocol
May 15, 2003

- Thank the teacher for observation.
- The interview will take about 20 minutes.
- Explain the process (no right or wrong answers, confidentiality). Get their permission to tape record. Ask if they have any questions before getting started.

Introduction

1. How do you think the *SEA* resources worked during your class?
2. Would you teach this class using the *SEA* resources again? Why or why not? Would you change something next time?

General

3. Please tell us your overall impressions of the process of finding, choosing, and adapting the resources for use in your class? In what ways could the *SEA* Web site/CD better support this process?
4. Now that you have used the resources in a lesson, is there anything that you wish *SEA* provided beforehand to help you prepare?
5. What did you enjoy most about using *SEA*? What did you enjoy least?

Professional Development

6. Please tell me your overall impressions about the Internet as a source for planning lessons. Has working with *SEA* had an impact on how you think about these things?
7. Have you taught much aquatic science in the past? In what ways might access to *SEA* materials change the ways you teach these topics in the future?

Technical

8. *If they used the Web site:* In what ways has your perception of the Web site changed now that you have used something from it?

Students

9. What do you think your students took away from the class? How do you think *SEA* contributed to their learning? What do you think they would have missed by not using the *SEA* resources?
10. What do you think your students enjoyed most about the resources? Least?

Closing

11. With what other concepts or themes would you consider using *SEA* resources? Are there any particular lesson plans you'd like to be able to get from *SEA*?
12. Do you have any questions for me?

Thanks again for your time.

APPENDIX D: SAMPLE PROTOCOL FOR INTERVIEWS WITH TEACHERS

Shedd Educational Adventures/On-line Teacher Resources Summative Evaluation John G. Shedd Aquarium

Interview Protocol June 9, 2003

- Introduce your self (what you're doing, why it's important to talk to them, etc.; explain that you're an independent consultant).
- The interview will take about 30-40 minutes.
- Explain the process (no right or wrong answers, confidentiality). Get their permission to tape record. Ask if they have any questions before getting started.

Introduction

1. Could you briefly describe your experience with *SEA* resources in your class?

General

2. Please tell us how you used *SEA* resources with your class. Which resources did you use? How did you choose those particular resources? In what ways did they fit into your curriculum (e.g., did you use them to fill in an existing lesson? Did you develop a new lesson that related to a concept or theme? etc.).
3. How did the resources you chose support your school or district curriculum? In what ways did they support state standards?
4. How did you find the *SEA* resources you used? From contact with Shedd? Through another teacher or word-of-mouth? Your principal or media specialist distributing the info? Did you go to the *SEA* Web site, or use the CD?
5. Please tell us your overall impressions of the process of finding, choosing and adapting the resources for use in your class? In what ways could the *SEA* Web site/CD better support this process?
6. *If they used the Web site:* How easy was it to find what you needed on the Web site? What were your overall impressions of the site (i.e., is it a trustworthy source of information)?
7. What other sorts of materials did you use along with the *SEA* resources? Where did they come from, and how did you find them?
8. In what ways did you have to prepare in order to use these resources in your classroom (e.g., did you have to walk through the lesson? Use the interactive yourself? Do more research on a topic? etc.)? Is there anything that you wish *SEA* provided beforehand in order to help you prepare?
9. *If they used a lesson plan:* Was there anything you needed that the on-line lesson did not mention or provide?
10. *If they used an activity:* Did you find anything missing from the activity that would have helped you prepare to use it?

Professional Development

11. Please tell me your overall impressions about the Internet as a source for planning lessons. Has working with *SEA* had an impact on how you think about these things?
12. Have you taught much aquatic science in the past? In what ways might access to *SEA* materials change the ways you teach these topics in the future?

Technical

13. Thinking back to when you were using the Web site or CD, what kinds of things did you do on the site? Did you search for key words? Copy text to Word? Download lessons? Print worksheets? Did you have any problems doing these things?

Enjoyment

14. What did you enjoy most about using *SEA*? What did you enjoy least?

Students

15. How do you think the *SEA* resources worked for your students during your class?

16. What do you think your students took away from using the *SEA* resources?

17. How do you think *SEA* contributed to their learning? What do you think they would have missed by not using the *SEA* resources?

18. What do you think your students enjoyed most about the resources? Least?

Closing

19. Would you teach this class using the *SEA* resources again? Why or why not? Would you change something next time?

20. Are there any other parts of your teaching where you would consider using *SEA* resources? Are there any particular lesson plans that you'd like to be able to get from *SEA*?

21. Do you have any questions for me?

Thanks again for your time.

APPENDIX E: ON-LINE SURVEY QUESTIONS

Note: Shedd intends to divide these questions into three separate surveys that will run at different times on the SEA Web site.

1. How did you find out about the Shedd Educational Adventures (SEA) part of the Shedd Aquarium's Web site?
 - A search engine
 - From Shedd's home page
 - Another teacher
 - A library/media specialist
 - Shedd Aquarium staff
 - Shedd Aquarium's printed materials
 - Shedd Educational Adventures CD-ROM
 - Other (please list): _____

2. Please tell us what parts of the SEA Web site you looked at: (Check all that apply)
 - Lesson plans:
 - Something Fishy
 - Pretty Smart for a Hammerhead
 - Making Sense of Sharks
 - Environmental Action Program
 - Read a Fish
 - Dining Out in the Coral City
 - Reefs at Risk
 - There Are Lots of Fish in the Sea...

 - Interactives:
 - Squish the Fish
 - Build-a-Fish
 - Mysteries of Apo Island
 - Conservation Investigation: Seahorses

 - Explorer's Guide:
 - Plants and Animals
 - People and Culture
 - Places: Land and Sea
 - Plantas y animales
 - Pueblos y culturas
 - Lugares: tierra y mar

3. How useful were the items you referred to?
 - Not useful
 - Somewhat useful
 - Very useful
 - Extremely useful

4. Was there anything on the SEA Web site that you were not able to open and use with your computer? (Check all that apply)
 - Lesson plans:
 - Something Fishy
 - Pretty Smart for a Hammerhead
 - Making Sense of Sharks

- Environmental Action Program
- Read a Fish
- Dining Out in the Coral City
- Reefs at Risk
- There Are Lots of Fish in the Sea...

Interactives:

- Squish the Fish
- Build-a-Fish
- Mysteries of Apo Island
- Conservation Investigation: Seahorses

Explorer's Guide:

- Plants and Animals
- People and Culture
- Places: Land and Sea
- Plantas y animales
- Pueblos y culturas
- Lugares: tierra y mar

5. Did you use the Technical Help page?

- No, because I didn't need it
- No, because I couldn't find it
- Yes

5a. If Yes:

- What topic did you refer to?
 - Web Browser for Apple
 - Web Browser for Windows
 - Macromedia Flash Plug-in for Apple
 - Macromedia Flash Plug-in for Windows

5b. How helpful was the information?

- Not helpful
- Somewhat helpful
- Very helpful
- Extremely helpful

6. Were there any other aspects of the *SEA* Web site that were hard for you or your students to use?

- Freeform

7. Please list any additional resources we could add to the Web site

- Freeform

8. Are you a

- Teacher?
- Home school teacher?
- Student?
- Parent?
- Other? (please list): _____

8a. (If teacher/home schooler) What grade do you teach? (Check all that apply)

- list Pre-K to 12+

8b. (If teacher/home schooler) What subject do you teach? (Check all that apply)

- General education
- General science
- Earth science
- Biology
- Chemistry
- Physics
- Environmental science
- Other (please list): _____

8c. (If teacher/home schooler) In what state do you teach?

- Pull down choice of 50 states + outside the US?

8d. (If teacher/home schooler) In what sort of community do you teach?

- Urban
- Suburban
- Rural

8e. (If student, parent, other) In what state do you live?

- Pull down choice of 50 states + outside the US?

9. What other sites for science and education do you use frequently? (Check all that apply)

- Discovery.com
- Scholastic.com
- Yahoo.com
- EPA.gov
- NASA.gov
- USGS.gov
- askEric.org
- PBS.org
- Museum website: (please list): _____
- University website (please list): _____
- Other (please list): _____

Thank you!

APPENDIX F: STUDENTS' ADVICE ABOUT *BUILD-A-FISH*

As part of the summative evaluation, we observed a third-grade class play *Build-a-Fish* for (at a minimum) the third or fourth time. Many of these students had first played the game during the formative evaluation, and they had also played at least once about a month after the evaluation.

We asked these students to write down the advice that they would give other students about how to win at *Build-a-Fish*. Many of them wrote advice both before and after they played that day. What follows is a transcription of their writings. (The before-and-after advice is separated by a solid line.)

Student A. First you want to get a fast body, then pick the rocket body. If you want to gulp other fish, [then] for a head pick "gulps other fish." If you want to have a great barracuda, then pick the silver color for the body. After you do you will see best habitat for your body and then best habitat for your pattern and last best food for your mouth.

Student B. If you want a fast fish, get a rocket body.

If you want a good turning and escaping fish, get a pancake body.

If you want a good hiding and sneaky fish, get a noodle body.

If you want a biter, he is good, or you can get a gulper one or a bottom feeder, or if your one who is a reef eater you can pick. I like you can get a gray color, a dotted color or lined or one with an eyeball. I like a rocket body, a fish who eats other fish, and stripped color. To stop hit return or enter. To eat use space bar. To move use the arrow keys. You have to get your energy full. To find fish in the water press the fish button of your fish.

Student C. Get a rocket body. If your fish has sharp teeth, find a fish without sharp teeth, [and] then you can eat that fish.

If you keep on losing you will starve.

Student D. If you have sharp teeth, you can eat a fish without sharp teeth. A fish with spots eats a fish with stripes.

Student E. Body: Rocket bodies are good because it can swim fast in a straight line in open waters.

Mouth: Bottom feeding mouths are OK because it's easy to find your food and the food you eat doesn't move.

Pattern: A silver body color can keep you camouflaged in open water.

Bottom feeder mouth, noodle body, and reef pattern is the best combo in my opinion.

Student F. Body: Pancake body because it can make tight turns

Mouth: The reef grazer and the bottom feeder are like easy to survive with.

Color: For the reef grazer the best color is the bluish gray color. For the bottom feeder, the peach with black spots is the best.

I would pick the bottom feeder mouth or the reef grazer mouth with the pancake body, and the color would be the polka dotted one or the blue one!

Student G. Here are some ways to win the game!

You want to read about the body, mouth, and face because it tells you what it eats and what can eat it. The rocket fish body can swim fast in a straight line in open water. The pancake fish body can make tight turns and swim through passages through the reef. The noodle fish body can hide in between cracks. I gave the facts to help you. The noodle fish is slower than the others.

Student H. The rocket body makes it easy to swim. If you choose a rocket body you should choose a mouth to eat other fish and a blue pattern to blend in with the water. The noodle body should eat coral or shrimp. The pancake body goes with any mouth you choose.

Student I. To [illegible] to the screen try to move fast.

If you pick a mouth that eats shrimp and crabs you will win.

Student J. The rocket body is the fastest.

The big mouth is good for gulping other fish.

Striped is good for confusing.

The rocket body, the sharp teeth, and silver body is good for catching prey.

Student K. If you eat a small fish and you are a big fish you can eat it.

Student L. If you pick shark teeth you can eat other fish.

Biter fish eat coral. Be careful big fish can eat [you?]

Student M. Use a rocket body, bites other fish mouth, and silver pattern. Stay above waters. Eat pancake and noodle bodies.

The harder you press the faster you go.

Student N. One of the best fish is the one with a rocket body, a biting mouth, and a silver color.